

Westinghouse Electric Company LLC Hematite Decommissioning Project 3300 State Road P Festus, MO 63028 USA

ATTN: Document Control DeskDirect tel:314-810-3353Director, Office of Federal and State Materials and<br/>Environmental Management ProgramsE-mail:pallagke@westinghouse.comU.S. Nuclear Regulatory CommissionOur ref:HEM-17-16Washington, DC 20555-0001Date:March 1, 2017

Subject: Westinghouse Hematite Decommissioning Project - Request for NRC Review of Final Status Survey Final Report Volume 3, Chapter 9, Survey Area Release Record for Land Survey Area 12, Survey Units 03, 04, 05, 06, 07, 08, and 09, Revision 1 (License No. SNM-00033, Docket No. 070-00036)

The purpose of this letter is to provide for the U.S. Nuclear Regulatory Commission (NRC) review of the FSS overview document Final Status Survey Final Report Volume 3, Chapter 9, Survey Area Release Record for Land Survey Area 12, Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through LSA 12-09), Revision 1.

The NRC provided feedback during recurring weekly publicly noticed teleconferences in regards to the application of the WRS Test when applied to the Three Stratum approach. Westinghouse and the NRC discussed the path forward and resolution of the NRC comments. As such, Revision 3 to FSSFR Volume 3 Chapter 1 implemented the resolution of the comments {ML17046A005}. Revision 1 of FSSFR Volume 3, Chapter 9 implements Revision 3 to FSSFR Volume 3 Chapter 1 within the release record.

Attachment 1 contains Final Status Survey Final Report Volume 3, Chapter 9, Revision 1, with a CD containing the revised Appendices. Attachment 2 contains a Track Change version of Final Status Survey Final Report Volume 3, Chapter 9, Revision 1, for ease of review.

Please contact me at 314-810-3353, should you have questions or need additional information.

Sincerely,

s pre

Kenneth E. Pallagi Licensing Manager, Hematite Decommissioning Project

NM5520

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- Attachment: 1) Final Status Survey Final Report Volume 3, Chapter 9, Survey Area Release Record for Land Survey Area 12, Survey Units 03, 04, 05, 06, 07, 08, and 09, (LSA 12-03 through LSA 12-09) (HDP-RPT-FSS-211) with a CD containing Appendices
  - Final Status Survey Final Report Volume 3, Chapter 9, Survey Area Release Record for Land Survey Area 12, Survey Units 03, 04, 05, 06, 07, 08, and 09, (LSA 12-03 through LSA 12-09) Track Change Version
- cc: J. W. Smetanka, Westinghouse M. R. Meyer, NRC/DUWP/MDB J. A. Smith, NRC/DUWP/MDB

# Attachment 1

# Final Status Survey Final Report Volume 3, Chapter 9

Survey Area Release Record for Land Survey Area 12, Survey Units 03, 04, 05, 06, 07, 08, and 09, Revision 1 with a CD containing Appendices

Westinghouse Electric Company LLC, Hematite Decommissioning Project

Docket No. 070-00036

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# **Final Status Survey Report**

# Hematite Decommissioning Project

Final Status Survey Final Report Volume 3, Chapter 9

#### TITLE:

Survey Area Release Record for Land Survey Area 12, Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)

**REVISION:** 

1

EFFECTIVE DATE: MAR 0 1 2017

**Approvals:** 

Author:

Kenneth E. Pallagi

03-01-2017

Date

Date

Owner/Manager:

W. Clark Evers

HDP-RPT-FSS-211

Hematite<br/>Decommissioning<br/>ProjectFSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12,<br/>Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)Revision: 1Page i of xvi

Revision No. Effect. Date	Revision			
0 01/03/2017	Revision 0 is the initial issuance of the Survey Area Release Record for Land Survey Area 12, Survey Units 03, 04, 05, 06, 07, 08, and 09.			
1 See Cover Page	The NRC provided feedback during recurring weekly publicly noticed teleconferences in regards to the application of the WRS Test when applied to the Three Stratum approach. Westinghouse and the NRC discussed the path forward and resolution of the NRC comments. Revision 3 to FSSFR Volume 3 Chapter 1 implemented the resolution of the comments. Revision 1 of this Survey Area Release Record implements Revision 3 to FSSFR Volume 3 Chapter 1 within this report.			

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		LIST OF ACRONYMS	AND SYMBOLS	
	ALARA	As Low As Reasonably Achievable	2	
	bgs	below ground surface		
	CFR	Code of Federal Regulations		
	cm	centimeter(s)		•
	cpm	count(s) per minute		
	CSM	Conceptual Site Model		
	DCGL	Derived Concentration Guideline I	evel	
	DCGL <sub>w</sub>	DCGL for average concentrations	over a survey unit, used with sta	tistical tests.
		"W" suffix denotes "Wilcoxon")		
	DGPS	Digital Global Positioning System		
	DP	Iematite Decommissioning Plan		
	DQO	Data Quality Observation		
	EMC	Elevated Measurement Comparison	1	
	EPA	J.S. Environmental Protection Age		
	ft	oot (feet)		
	FSS	Final Status Survey		
	FSSFR	Final Status Survey Final Report		
		gross count(s) per minute		
	gcpm GIS	Graphical Information Software		
	GPS	Global Positioning System		
	GWS	- · ·		
		Gamma Walkover Survey	+	
	HDP	Hematite Decommissioning Projec		
	HP	Health Physics	tion Down at	
	HRCR	Hematite Radiological Characteriz	ation Report	
	I&C	solation and Control		
	IAL	nvestigation Action Level		
	LSA	Land Survey Area		
	m2	neter(s)		
	m <sup>2</sup>	square meter(s)	1 Oite Lune stie stien Mennel	
	MARSSIM	Multi-Agency Radiation Survey ar	a Site Investigation Manual	
	MCL	Maximum Concentration Limit		
	MDC	Minimum Detectable Concentratio	n	
	mrem	nilliroentgen equivalent man		
	NAD	North American Datum		
	NaI	Sodium Iodide		
	ncpm	net count(s) per minute		
	NCS	Nuclear Criticality Safety		
	NRC	J.S. Nuclear Regulatory Commiss	ion	,
	pCi/g	bicocurie(s) per gram		
	QC	Quality Control		. `
	Ra	Radium		
	RASS	Remedial Action Support Survey		
	RSO	Radiation Safety Officer		
	SOF	Sum of Fractions		

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Tc Th U WRS	Survey Unit Technetium Thorium Uranium Wilcoxon Rank Sum year		
•			
		••	

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## **EXECUTIVE SUMMARY**

This Survey Area Release Record (SARR) presents the results of the final status radiological surveys of the Hematite Decommissioning Project (HDP) Land Survey Area (LSA) 12, Survey Unit (SU) 03 (LSA 12-03), SU 04 (LSA 12-04), SU 05 (LSA 12-05), SU 06 (LSA 12-06), SU 07 (LSA12-07), SU 08 (LSA 12-08), and SU 09 (LSA 12-09). As provided in Final Status Survey Final Report (FSSFR), Volume 1, Chapter 1, Section 7.0 {ML15257A307}, the final report summary, FSSFR Volume 7, *Final Status Survey Final Report*, will be submitted at the conclusion of the post-remediation groundwater monitoring period. FSSFR Volume 7 will be submitted to demonstrate that the site has met the requirements for unrestricted release consistent with the requirements of the Title 10 Code of Federal Regulations (CFR) 20 Subpart E, "Criteria for License Termination."

LSA 12-03 through LSA 12-07 were designated as Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) Class 1 SUs as presented in Table 14-16 of the HDP Decommissioning Plan (DP) {ML092330123}. The Class 1 designation for LSA 12-03 through LSA 12-07 remained in effect throughout remediation of the site and Final Status Survey (FSS). SUs LSA 12-08 and LSA 12-09 were created from a portion of the land area initially identified as LSA 12-02 a Class 2 SU. SUs LSA 12-08 and LSA 12-09 were designated as Class 1 SUs upon establishment of the SU boundaries. For all LSA 12 SUs the evaluation of analytical results against the Derived Concentration Guideline Levels (DCGL) for the Uniform Stratum Conceptual Site Model (CSM) was the selected approach. The objective of the FSS for all SUs was to obtain and document measurement results, analytical data, and other supporting information in order to demonstrate that after completion of operations the residual radioactivity levels in the LSA 12-03 through LSA 12-09 SUs are below the applicable Uniform Stratum DCGLs and therefore the land area of these SUs meet the criteria for unrestricted release.

The Uniform Stratum CSM assumes residual radioactivity is uniformly distributed over the entire depth profile of the SU from ground surface to 6.7 meter (m) below ground surface (bgs). As described in FSSFR Volume 3, Chapter 1, 6.2.1, *Systematic Soil Sampling*, systematic soil samples were obtained at depths dependent upon the systematic soil sample location.

This SARR was prepared as described in FSSFR Volume 3, Chapter 1, Section 7.0, *Survey Area Release Record Organization*, as implemented by FSS procedure HDP-PR-FSS-722.

#### **1.0 REPORT BACKGROUND**

As a result of the U. S. Nuclear Regulatory Commission (NRC) feedback regarding the submittal of the FSSFR, Westinghouse and the NRC agreed that Westinghouse would develop an outline presenting the format and content of FSS documents required for NRC review. Westinghouse provided the outline to the NRC for discussion during the August 19, 2015, publicly noticed teleconference and the format was agreed upon {ML15238B032}.

FSSFR Volume 3, Chapter 1, Revision 3, *Land Survey Areas (LSA) Overview* provides the information common to land survey areas. This report, FSSFR Volume 3, Chapter 9, Revision 1, builds upon the general information provided in FSSFR Volume 3, Chapter 1, Revision 3.

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# 2.0 HDP SITE, LSA AND SURVEY UNIT DESCRIPTIONS

# 2.1 HDP Site Description

A general description of the HDP site is given in FSSFR Volume 1, Chapter 1.

# 2.2 LSA Configuration

The DP Chapter 14 and DP Figure 14-14 provided the conceptual approach for the configuration of LSAs and the SUs within a LSA. Figure 2-1 indicates the LSA configurations for the HDP site.

The DP stated that it was expected that the conceptual boundaries of the SUs would be altered based on the actual configuration and condition of the SU at the time of survey design. As expected, it was necessary to modify the boundary of SUs within LSA 12 to facilitate the remediation process. Although a number of the SU boundaries within LSA 12 were modified, the boundary of LSA 12 remained unchanged

LSA 12 encompasses the entire "East Reuse Soil Laydown Area" footprint within the Central Tract. LSA 12 consists of SUs LSA 12-01 through LSA 12-09.

# 2.2.1 LSA 12 SU Configuration Change

The expansion in the number of SUs within LSA 12 by the reduction in size of LSA 12-02 was due in part to the processing and storage of reuse soil. As site remediation operations generated more than the anticipated volume of reuse soil it became necessary to expand the Class 1 storage area portion of LSA 12.

The initial configuration change transferred a portion of LSA 12-02, a Class 2 SU, to create LSA 12-08, a Class 1 SU. Subsequently LSA 12-08 was divided into LSA 12-08 and LSA 12-09 to ensure compliance with the DP Class 1 SU size requirement.

To support the remediation plans described in the DP, although radiological characterization of the land indicated it was radiologically non-impacted, SUs were developed based upon future use (reuse soil laydown area). All SUs within LSA 12 that were initially classified as Class 1 (LSA 12-03 through LSA 12-07) remained classified as Class 1 SUs. SUs LSA 12-01 and 12-02 were initially classified as MARSSIM Class 2 and remained Class 2 SUs. The portion of LSA 12-02 that became LSA 12-08 and LSA 12-09 had the classification raised to MARSSIM Class 1 SUs, thereby ensuring compliance with the DP. Figure 2-2 provides the Final Configuration of Land Survey Area 12 and Survey Units. Figure 2-3 provides the Final Configuration of Land Survey Areas and Survey Units.

# 2.3 LSA 12-03 through LSA 12-09 Survey Unit Description and Configuration

The land area that is LSA 12-03 through LSA 12-09, prior to and during site operations was woodlands (see Figure 2-4) and not associated with or impacted by any site operations. There were no structures, piping, spent limestone or groundwater monitoring wells within the SUs. As a function of preparation for remediation operations, trees and vegetation were removed from

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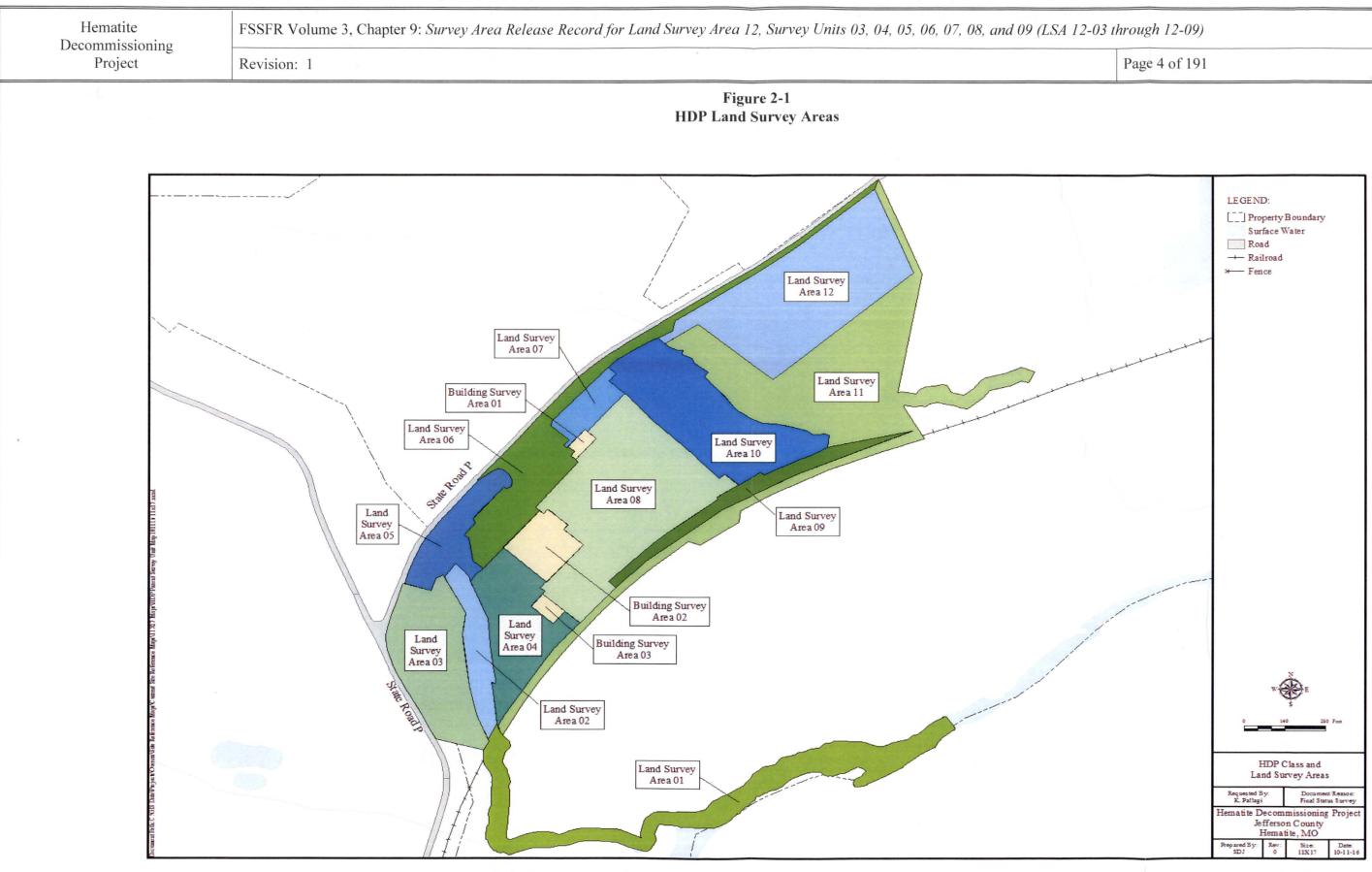
LSA 12-03 through LSA 12-09 and the area was graded to create the material laydown area for the reuse soil to be generated (see Figure 2-5).

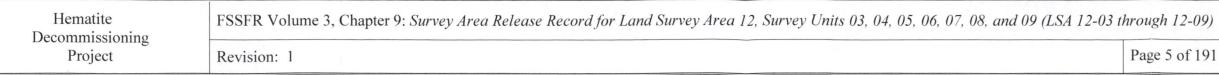
As all reuse soil that was placed in LSA 12-03 through LSA 12-09 was subsequently removed and used as backfill in site excavations, remediation was not necessary in LSA 12-03 through LSA 12-09 to prepare the area for FSS. As such no excavations were performed to remove reuse or any native soil. The final surface of the SUs that was subject to FSS was the native soil.

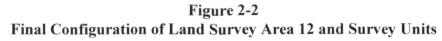
Upon completion of the removal of all reuse soil, in its final configuration as prepared for FSS, the two dimensional surface area of each SU is listed below:

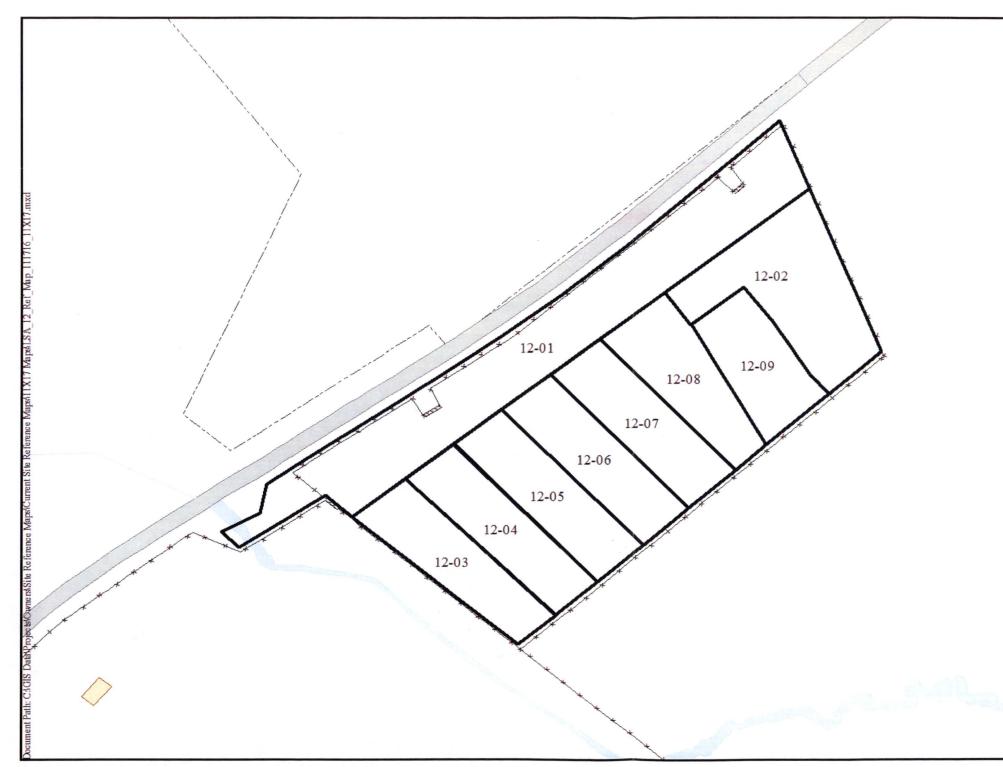
Table 2-1LSA 12 Class 1 SU Surface Areas

LSA 12-03	LSA 12-04	LSA 12-05	LSA 12-06	LSA 12-07	LSA 12-08	LSA 12-09
$1,982 \text{ m}^2$	$1,960 \text{ m}^2$	$2,001 \text{ m}^2$	1,994 m <sup>2</sup>	1,996 m <sup>2</sup>	$1,995 \text{ m}^2$	1,747 m <sup>2</sup>



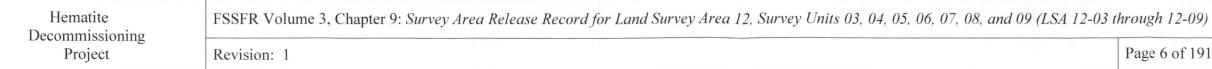






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LEGEND: Land Survey Area 12 Buildings [\_]Property Boundary Surface Water State Road P --- Railroad - Fence Requested By: K. Pallagi Document Reason: Final Status Survey HDP Land Survey Area 12 Reference Map Hematite Decommissioning Project Jefferson County Hematite, MO Prepared By: Rev: SDJ 0 Size: Date: 11X17 11-17-16



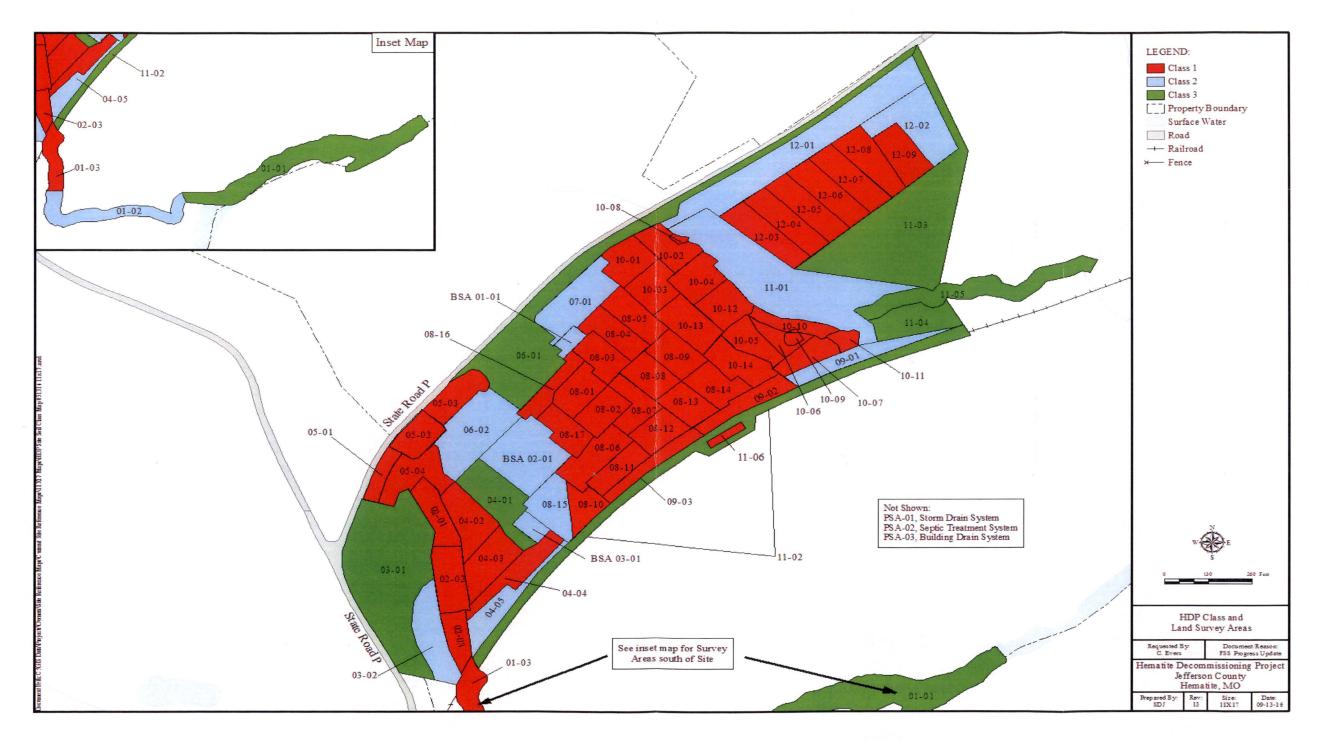


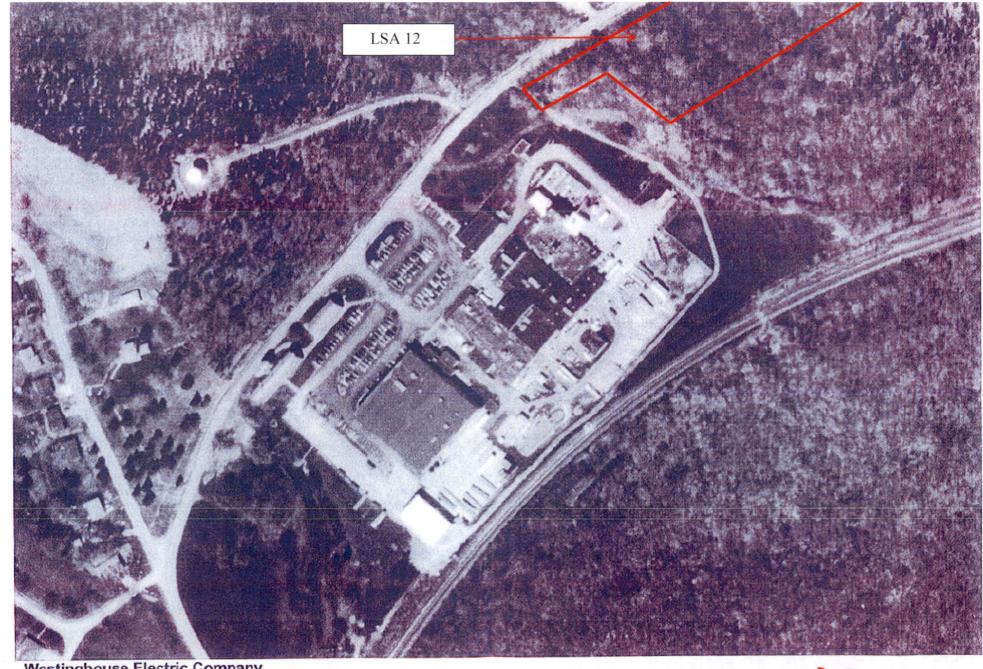
Figure 2-3 Final Configuration of Land Survey Areas and Survey Units

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Figure 2-4 Hematite Site Aerial Photograph – 04/02/1998 (Indicating General Location of LSA 12)



Westinghouse Electric Company Hematite Plant - Festus, MO 4/2/1998

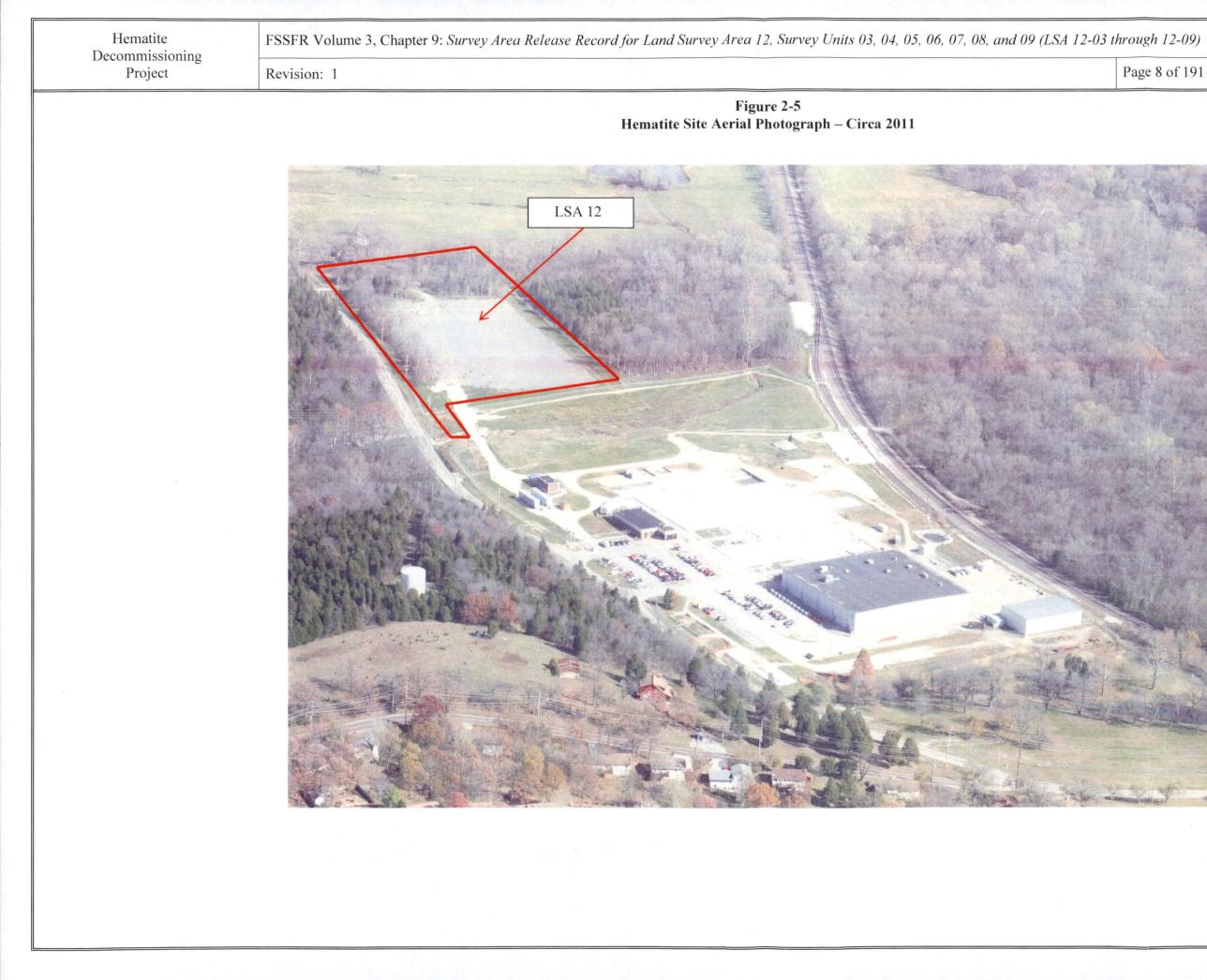
Photo Source: Surdex Corp.





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## 3.0 HISTORY OF OPERATIONS

A discussion of site historical operations prior to the decommissioning phase of the HDP is presented in the FSSFR Volume 1, Chapter 1, Section 3.0, *Site Historical Operations*.

A detailed discussion of the historical background information related to the general remediation process is presented in the FSSFR Volume 3, Chapter 1, Section 2.1.1, *Remediation and Excavation*.

A detailed discussion of the historical background information related to reuse soils is presented in the FSSFR Volume 2, Chapter 1, Section 2.1, *History and Development of the Reuse Soil Stockpiles*.

# 3.1 Potential Radioactive Materials in LSA 12-03 through LSA 12-09

Potential radioactive materials within LSA 12-03 through LSA 12-09 resulted from placement of potential reuse soil into the SUs for the purpose of long term reuse soil storage. During the time of reuse soil handling at HDP, Reuse Stockpiles 1 through 7, and Reuse Stockpile 9 were stored within the "East Reuse Soil Laydown Area".

No remedial actions were necessary within LSA 12, and no historical site operations ever occurred within this area. The LSA 12 area only became potentially impacted as a result of the long term storage of potential reuse material.



Figure 3-1 Reuse Soil Stockpile Operations – 07/2013

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## 3.1.1 ISO-Pacific S3 Soil Sorting System Operations

As described in FSSFR Volume 2, Chapter 1, Section 2.1.1 {ML16152A752}, to address the issue of identification of fuel pellet fragments in reuse soil, Westinghouse evaluated options to address the issue and selected the ISO-Pacific S3 Soil Sorting System. As reuse soil was stored in LSA 12-03 through LSA 12-09 there was a potential for a fuel pellet fragment to be transferred into the area.

The ISO-Pacific S3 Soil Sorting System operations, the removal of all reuse soil from the East Reuse Soil Laydown Area, and the subsequent 100% Gamma Walkover Survey (GWS) of SUs during FSS LSA 12-03 through LSA 12-09, collectively demonstrate that the probability of a fuel pellet fragment remaining in a SU is exceedingly small.

#### 3.2 Reuse Soil Disposition and Characterization

Prior to remediation and removal of contaminated soil and other waste materials within the Burial Pit Area and other areas designated to undergo remediation, overburden soils which exhibited characteristics suitable for potential reuse as onsite backfill material were removed, segregated, and subjected to reuse soil criteria requirements.

As LSA 12 was not designated for and did not require remediation there were no reuse soils generated by remediation excavation within the LSA 12 area. However it is noted that during movement of reuse stockpiles during the ISO-Pacific S3 Soil Sorting System sorting operations that a small quantity of the surface of the overburden from the LSA 12 land area was most likely removed and deposited into Reuse Stockpile 9 as a result of the creation of the stockpile. Global Positioning System (GPS) measurements in LSA 12 did not indicate a discernable change in surface elevation.

A detailed discussion of reuse soils, including general description, segregation, surveys, ISO-Pacific S3 sorting technology and operations, and technical requirements may be found in the FSSFR Volume 2, Chapter 1, *Reuse Soil and Off-site Borrow Material Overview* {ML16152A752}.

#### 3.3 Remedial Action Support Surveys (RASS) Phase of LSA 12-03 through LSA 12-09

The sections below provide a discussion of the various elements of the RASS phase of LSA 12-03 through LSA 12-09 necessary to prepare the SUs for FSS.

#### 3.3.1 Remedial Actions

No remedial actions were performed within the LSA 12 area. After all reuse soil was removed from the area, the area was prepared for Final RASS and FSS.

# 3.3.2 In Process Remedial Action Support Surveys

In process RASS was not required within LSA 12 since no remediation was performed.

# 3.3.3 Nuclear Criticality Safety (NCS) Borings

NCS Borings were not required within LSA 12 as the area was never subject to NCS controls.

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# 3.3.4 Groundwater Monitoring Wells

A detailed discussion of history, purpose, use, issues, and results of the groundwater monitoring wells at HDP is presented in the FSSFR Volume 6, Chapter 1.

During the history of site operations and remediation no groundwater monitoring wells were located within the boundary limits of LSA 12-03 through 12-09.

# 3.3.5 Subterranean Piping

Preliminary remediation planning activities indicated that no subterranean process piping should be encountered in LSA 12-03 through LSA 12-09. During reuse stockpile operations within LSA 12-03 through LSA 12-09 no subterranean process piping was encountered.

As no buried piping remains under the footprint of LSA 12-03 through LSA 12-09 there is no dose contribution from this pathway.

# 3.3.6 Characterization History

The LSA 12 area was not impacted by historic site operations, was previously covered by a heavily wooded area, and identified as a non-impacted area in the Historical Site Assessment.

Although the LSA 12 area was considered a non-impacted area, it was determined that the area would be potentially impacted by future site operations and therefore the LSA 12 area was identified for FSS purposes in the DP. During the remediation planning process this area was identified as a potential reuse soil staging area. Brush clearing operations in 2011 removed a majority of the trees and brush from the landscape.

As a non-impacted area during site operations there were no characterization core bores performed within the LSA 12 area. FSS Planning was based on the information collected in the Final RASS.

# 3.3.7 Remedial Action Support Survey for FSS Design

The RASS was conducted within LSA 12, 1) to determine when a SU had been adequately prepared for FSS, and 2) to provide updated estimates of the parameters to be used for planning the FSS. Upon the removal of all reuse soil from the survey unit and prior to implementation of FSS activities, a final RASS was performed to validate the status of the SU prior to implementing Isolation and Control (I & C) postings. The I & C posting for LSA 12-03 through LSA 12-09 was completed on April of 2016. Figure 3-2 is a photograph which shows LSA 12-03 through LSA 12-09 ready for the final RASS.

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Figure 3-2 LSA 12-03 through LSA 12-09 Prepared for RASS FSS Design



The RASS included a GWS, systematic surface sample collection based on a sixteen (16) point triangular grid, and biased surface sampling. Since LSA 12-03 through 12-09 were immediately adjacent to each other, and were similar, one Final RASS survey was performed over all the SU's concurrently. The Final RASS results were used to develop the FSS Plan for each SU. The Final RASS systematic sample results used to develop the FSS sampling grid are summarized in Table 3-1 below:

LSA	Ra-226 (net)		Tc-99		Th-232 (net)		U-234		U-235		U-238	
	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max
12-03 through 12-09	0.00	0.00	0.53	2.42	0.03	0.21	5.24	9.95	0.29	0.55	1.48	2.30
$DCGL^3$	1.	.9	25	5.1	2	.0	19:	5.4	51	.6	16	8.8

Table 3-1					
Summary of Final RASS Results for LSA 12-03 through LSA 12-09					

1. All units are in picocuries per gram (pCi/g)

2. Results reflect net concentrations after subtraction of background (Ra-226 bkg = 0.9 pCi/g; Th-232 bkg = 1.0 pCi/g).

3. Uniform Stratum DCGLs (From Table 4-1)

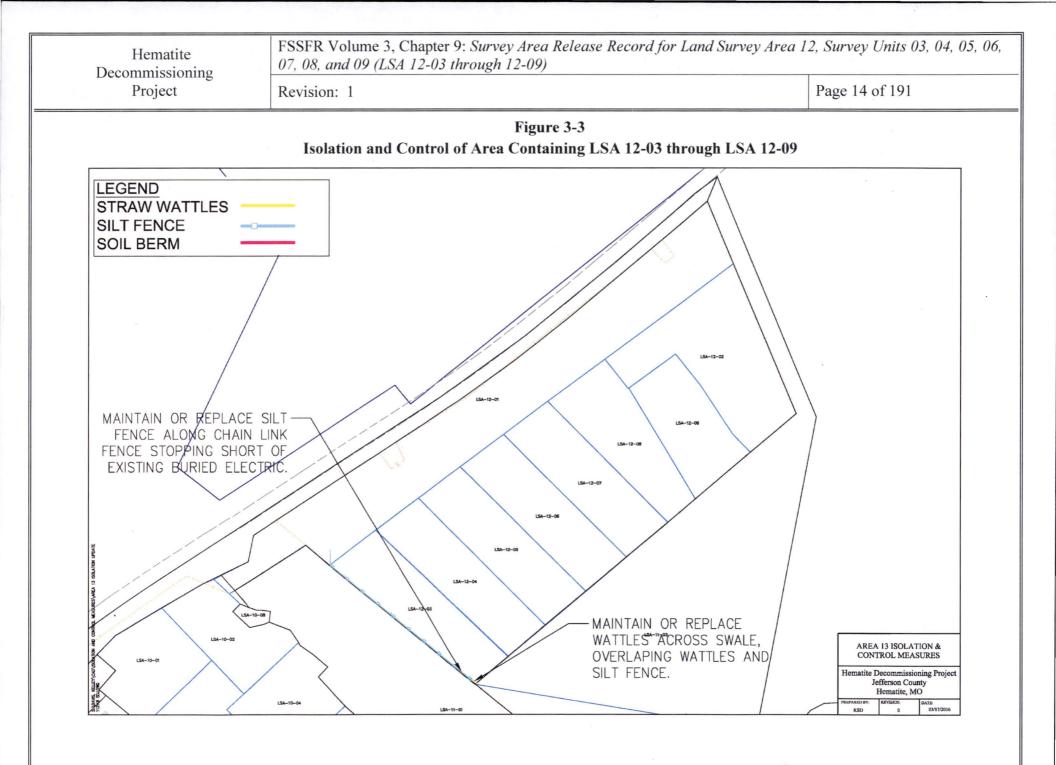
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All Final RASS systematic sample and biased sample results were less than the appropriate  $DCGL_w$  (Uniform Stratum) and the Final RASS data set was considered sufficient to support FSS design.

#### 3.3.8 Isolation and Control

As directed by HDP-PR-HP-602, *Data Package Development and Isolation and Control Measures to Support Final Status Survey*, in April of 2016, LSA 12-03 through LSA 12-09 were isolated and controlled in accordance with Work Package HDP-WP-ENG-803, *Isolation and Control Measures*, (See Figure 3-3) Isolation and control measures included silt fence, straw wattle, and soil berms between these SUs and the adjacent remediation area to ensure that cross-contamination of these LSAs undergoing FSS did not occur.

The administrative control of multiple postings labeled "Contact Health Physics Prior to Entry" were installed around the entire perimeter of the SUs prior to FSS field activities to prevent inadvertent entry by site personnel. LSA 12-03 through LSA 12-09 are located within the fenced security perimeter of the HDP which therefore prevents access by the general public.



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#### 3.3.9 Surveillance Following FSS

Following the completion of a FSS, the DP requires continued surveillance to minimize the potential to re-contaminate a SU (e.g., surface water transport of potentially contaminated sediment or a soil pile that was not present during FSS). The surveillance included the routine visual inspection of the integrity of the I & C measures implemented for LSA 12-03 through LSA 12-09. If a SU is suspected of having been re-contaminated then an investigation survey will be performed to reconfirm the FSS survey validity.

During the timeframe since the completion of FSS field activities to the date of completion of all physical work at HDP and project demobilization, LSA 12-03 through LSA 12-09 did not evidence an event that would cause them to be suspect and thus require investigation.

#### 3.3.10 Backfill of Survey Units

No backfill was required for LSA 12-03 through LSA 12-09.

#### 3.3.11 Groundwater Monitoring

In response to NRC RAI Chapter 3-4, during the review and approval process for the DP, Westinghouse documented in letter HEM-11-96 {ML111880290} the revised text of DP Section 14.5.1 to be as follows:

"Post-remediation monitoring wells will be sampled quarterly after the completion of remediation until license termination. The data collected will be used to confirm that the sum of the annual dose from groundwater for all the radionuclides does not exceed the EPA Maximum Contaminant Level (MCL) of 4 millirem/year. Separately, the sum of the dose from all residual sources remaining after remediation, including soil and groundwater pathways, will be confirmed to result in an annual dose that does not exceed 25 millirem/year."

As stated in the Executive Summary section, the exposure results of this report will be combined with the dose attributed to groundwater to demonstrate that the site has met the requirements for unrestricted release consistent with the requirements of the Title 10 CFR 20 Subpart E, "Criteria for License Termination." As such, for the purpose of this report, groundwater will be assigned a conservative SOF of 0.16 which equates to 4 mrem/yr until such time that the post-remediation groundwater sampling has been completed and reported as part of FSSFR Volume 6, Chapter 7, *Post-remediation Groundwater Monitoring Summary*. The final dose for LSA 12-03 through LSA 12-09 will be reported in FSSFR Volume 7, reflecting the updated results of the post-remediation groundwater monitoring.

#### 4.0 LSA RELEASE CRITERIA

As the release criteria for all LSA SUs is common, FSSFR Volume 3, Chapter 1, Section 3.0, *Release Criteria*, provides a detailed discussion on the release criteria that is applicable to LSA 12-03 through LSA 12-09. Table 4-1 provides the applicable DCGLs.

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# Table 4-1Adjusted Soil DCGLw's by CSM<sup>a</sup>

	Three Layer A	Uniform			
Radionuclide	Surface Stratum	Root Stratum		Stratum (pCi/g)	
Radium-226+C <sup>d</sup>	5.0	2.1	5.4	1.9	
Technetium-99	151.0	30.1	74.0	25.1	
Thorium-232+C <sup>d</sup>	4.7	2.0	5.2	2.0	
Uranium-234	508.5	235.6	872.4	195.4	
Uranium-235+D <sup>c</sup>	102.3	64.1	208.1	51.6	
Uranium-238+D <sup>c</sup>	297.6	183.3	551.1	168.8	

<sup>a</sup> Table as presented in FSSFR Volume 3, Chapter 1.

<sup>b</sup> The reported DCGLw's are the activities for the parent radionuclide and were calculated to account for the dose contribution from insignificant radionuclides.

<sup>c</sup>+D indicates the DCGL<sub>w</sub> includes short-lived (half-life  $\leq 6$  mo.) decay products.

<sup>d</sup>+C indicates the DCGL<sub>w</sub> includes all radionuclides in the associated decay chain.

## 5.0 FINAL STATUS SURVEY DESIGN LSA 12-03

This section of the report describes the method for determining the number of samples required for the FSS of LSA 12-03 as well as summarizing the applicable requirements of the FSS Plan. These include the  $DCGL_W$ , scan survey coverage, and Investigation Action Levels (IAL). The radiological instrumentation used in the FSS of LSA 12-03 and the detection sensitivities are also discussed.

#### 5.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 12-03 were driven by the type (Open Land) and Class (Class 1) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development*, November 2015.

#### 5.1.1 Surrogate Evaluation Areas

A discussion of Surrogate Evaluation Areas is given in the FSSFR Volume 3, Chapter 1, Section 5.0, *Final Status Survey Design*.

#### 5.1.2 DCGL<sub>w</sub>

During the FSS design process a review was performed of the RASS data for LSA 12-03. The RASS data was used as confirmation that no known areas of residual radioactivity remained within the SU that exceeded the Uniform Stratum DCGL<sub>w</sub>. Therefore the Uniform Stratum DCGL<sub>w</sub> was selected for use in demonstrating compliance with the release criteria.

#### 5.1.3 GWS Coverage

As a Class 1 SU, LSA 12-03 was required to undergo a 100% GWS.

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# 5.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 12-03 was the Ludlum 44-10 2" x 2" sodium iodide (NaI) detectors, coupled to a Ludlum 2221 scaler-ratemeter.

## 5.1.5 Scan Minimum Detectable Concentration (MDC)

Scan MDCs for LSA 12-03 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD-FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. As background levels were approximately 9,000 counts per minute (cpm) within LSA 12-03, the scan minimal detection concentration (MDC) calculation for total uranium given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.2.6.d, was applied:

Scan MDC (total uranium) = 
$$\frac{1}{\left( \left( \frac{f_{U-234}}{3471 \ pCi/g} \right) + \left( \frac{f_{U-235}}{2.2pCi/g} \right) + \left( \frac{f_{U-238}}{29.0pCi/g} \right) \right)}$$
Equation 5-1

To determine isotopic Uranium fractions HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* assumes that the average LSA enrichment is 4% or less. Based on the systematically collected RASS samples in LSA 12-03, the average enrichment for the SU was 2.96%. All other Scan MDC parameters agreed upon between Westinghouse and the NRC were applied (e.g. use of a 2 in air gap, scan rate of 1 ft/sec, 0.75 surveyor efficiency), therefore no subsequent changes to the calculated Scan MDCs need to be made.

Prospectively calculated Scan MDCs for 2" x 2" NaI detectors that were used in LSA 12-03 are shown below:

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 12-03	38.8	50.9	1.14	2.8	0.82	3.0

Table 5-1Scan MDCs for 2" x 2" NaI detector, 9,000 cpm background: LSA 12-03

\*DCGL<sub>w</sub> includes background concentrations of 0.9 pCi/g for Ra-226 (no ingrowth) and 1.0 pCi/g for Th-232. DCGLw values are based on the Uniform Stratum release criteria.

The values in Table 5-1 reflect those presented in the FSS Plans prepared for the SU prior to FSS.

#### 5.1.6 Investigation Action Level

FSSFR Volume 3, Chapter 1, Section 6.1.3, *Investigation Action Level (IAL)*, provides a discussion in regards to the IAL. The basis of the IAL is detailed in HDP memorandum, HEM-15-MEMO-021 "Evaluation of the Scan IAL for Class 1 areas at the Westinghouse Hematite

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Site". The IAL used during the GWS of LSA 12-03 was established at 4,000 net counts per minute (ncpm).

# 5.1.7 LSA 12-03 FSS Design Summary

The FSS Plans for LSA 12-03 can be found in Appendix H. Table 5-2 presents an overall FSS design and implementation summary for LSA 12-03.

Table 5-2		
FSS Design Summary for LSA 12-03	ummary for LSA 12-03	<b>FSS Design</b>

Gamma Walkover Survey (GWS):	<u>.</u>	· • • • • • • • • • • • • • • • • • • •		
Scan Coverage			100% exposed soil and rock	
			Ci/g total Uranium (based on a 9,000	
Scan MDC		cpm ba	ackground); 0.82 pCi/g Th-232; 1.14	
		pCi/g F	Ra-226*	
Investigation Action Level (IAL)		4,000 r	net cpm **	
Systematic Sampling Locations:			· · ·	
Depth	Number of Samp	ole ·	Comments	
0-15 cm (Surface)	8			
15 cm – 1.5 m (Root)	8		These samples will be taken on a	
> 1.5m (Excavation)	8		random-start systematic grid.	
<b>Biased Survey/Sampling Locations</b>	•	I	i <u>i i i i i i i i i i i i i i i i i i </u>	
analysis of the survey data, or at the			of the HP Technician, after statistical blogical Engineering.	
analysis of the survey data, or at the of <b>Sidewall Sampling Locations:</b> A minimum of one (1) discretionary	direction of the RSO	or Radio		
analysis of the survey data, or at the of Sidewall Sampling Locations: A minimum of one (1) discretionary of "sidewall": sidewall candidates for	direction of the RSO	or Radio	blogical Engineering.	
analysis of the survey data, or at the operation of the survey data, or at the operation of sidewall Sampling Locations: A minimum of one (1) discretionary of "sidewall": sidewall candidates for 12" in height. Instrumentation: Ludlum 2221 with 44-10 (2x2 Nal)	direction of the RSO sidewall sample wil r sampling must be v	or Radio	blogical Engineering. lected based on the following definition or near vertical (> 45° angle) and at least GWS and to obtain static count rates at	
analysis of the survey data, or at the of <b>Sidewall Sampling Locations:</b> A minimum of one (1) discretionary of "sidewall": sidewall candidates for 12" in height. <b>Instrumentation:</b> Ludlum 2221 with 44-10 (2x2 Naff collimation for investigations	direction of the RSO sidewall sample wil r sampling must be v ) detector; with Us bia	or Radio I be coll rertical o ed for C used méa	blogical Engineering. lected based on the following definition or near vertical (> 45° angle) and at least GWS and to obtain static count rates at asurement locations.	
analysis of the survey data, or at the of <b>Sidewall Sampling Locations:</b> A minimum of one (1) discretionary of "sidewall": sidewall candidates for 12" in height. <b>Instrumentation:</b> Ludlum 2221 with 44-10 (2x2 Nall collimation for investigations *Values based on information provi	direction of the RSO sidewall sample wil r sampling must be v ) detector; with Us bia ded in HDP-TBD-FS	or Radio I be coll ertical o ed for C used méa SS-002,	blogical Engineering. lected based on the following definition or near vertical (> 45° angle) and at least GWS and to obtain static count rates at asurement locations. "Evaluation and Documentation of the	
analysis of the survey data, or at the of Sidewall Sampling Locations: A minimum of one (1) discretionary of "sidewall": sidewall candidates for 12" in height. Instrumentation: Ludlum 2221 with 44-10 (2x2 Naff collimation for investigations *Values based on information provi Scanning Minimum Detectable Convertioned	direction of the RSO sidewall sample wil r sampling must be v ) detector; with Us bia ded in HDP-TBD-FS centrations (MDC) for	or Radio I be coll rertical o ed for C used méa SS-002, for Final	blogical Engineering. lected based on the following definition or near vertical (> 45° angle) and at least GWS and to obtain static count rates at asurement locations. <i>"Evaluation and Documentation of the</i> <i>Status Surveys (FSS)</i> . The Scan MDC	
analysis of the survey data, or at the operation of the survey data and the survey data and the survey data and the survey data and the survey of the survey of the survey data and the survey of the survey of the survey data and the survey of th	direction of the RSO sidewall sample wil r sampling must be v ) detector; with Us bia ded in HDP-TBD-FS centrations (MDC) for rative assumption of	or Radio I be coll ertical o ed for C used méa SS-002, for Final 4% enri	blogical Engineering. lected based on the following definition or near vertical (> 45° angle) and at least GWS and to obtain static count rates at asurement locations. <i>"Evaluation and Documentation of the</i> <i>I Status Surveys (FSS)</i> . The Scan MDC ichment. The actual RASS enrichment	
analysis of the survey data, or at the of <b>Sidewall Sampling Locations:</b> A minimum of one (1) discretionary of "sidewall": sidewall candidates for 12" in height. <b>Instrumentation:</b> Ludlum 2221 with 44-10 (2x2 Nall collimation for investigations *Values based on information provi <i>Scanning Minimum Detectable Com</i> for total Uranium reflects a conserver (2.0%) would result in Scan MDC variable for the formation of the f	direction of the RSO sidewall sample wil r sampling must be v ) detector; with Us bia ded in HDP-TBD-FS centrations (MDC) for values slightly less than	or Radio I be coll rertical o ed for C used méa SS-002, for Final 4% enri n those c	blogical Engineering. lected based on the following definition or near vertical (> 45° angle) and at least GWS and to obtain static count rates at asurement locations. <i>"Evaluation and Documentation of the</i> <i>Status Surveys (FSS)</i> . The Scan MDC ichment. The actual RASS enrichment calculated for FSS planning purposes.	
analysis of the survey data, or at the of <b>Sidewall Sampling Locations:</b> A minimum of one (1) discretionary of "sidewall": sidewall candidates for 12" in height. <b>Instrumentation:</b> Ludlum 2221 with 44-10 (2x2 Naff collimation for investigations *Values based on information provi <i>Scanning Minimum Detectable Conf</i> for total Uranium reflects a conserver (2.0%) would result in Scan MDC var **IAL is the net count per minute (	direction of the RSO sidewall sample wil r sampling must be v ) detector; with Us bia ded in HDP-TBD-FS centrations (MDC) for ative assumption of alues slightly less than ncpm) equivalent of	or Radio I be coll rertical o ed for C used méa SS-002, for Final 4% enri an those c an activ	blogical Engineering. lected based on the following definition or near vertical (> 45° angle) and at least GWS and to obtain static count rates at asurement locations. <i>"Evaluation and Documentation of the</i> <i>I Status Surveys (FSS)</i> . The Scan MDC ichment. The actual RASS enrichment calculated for FSS planning purposes. <i>v</i> ity concentration less than the Uniform	
analysis of the survey data, or at the of <b>Sidewall Sampling Locations:</b> A minimum of one (1) discretionary of "sidewall": sidewall candidates for 12" in height. <b>Instrumentation:</b> Ludlum 2221 with 44-10 (2x2 Naff collimation for investigations *Values based on information proving Scanning Minimum Detectable Components for total Uranium reflects a conservert (2.0%) would result in Scan MDC van **IAL is the net count per minute ( Stratum DCGLw derived from the	direction of the RSO sidewall sample wil r sampling must be v ) detector; with Us bia ded in HDP-TBD-FS centrations (MDC) for rative assumption of ilues slightly less than ncpm) equivalent of technical bases prese	or Radio I be coll rertical o ed for C ased méa SS-002, for Final 4% enri n those c an activ ented in	blogical Engineering. lected based on the following definition or near vertical (> 45° angle) and at least GWS and to obtain static count rates at asurement locations. <i>"Evaluation and Documentation of the</i> <i>Status Surveys (FSS)</i> . The Scan MDC ichment. The actual RASS enrichment calculated for FSS planning purposes.	

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# 6.0 FINAL STATUS SURVEY IMPLEMENTATION LSA 12-03

FSS was performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.

# 6.1 Gamma Walkover Survey

#### 6.1.1 Instrumentation

The selected instrumentation to perform the GWS in LSA 12-03 was a 2" x 2" NaI detector in combination with a Ludlum 2221 rate meter. Each NaI instrumentation set was interfaced with a Trimble DGPS (Digital Global Positioning System) and handheld data logger.

Prior to the first field use of the GWS instrumentation, initial set-ups were performed. Also, daily pre- and post-use source checks were performed for each day that GWS was performed within the SU. Initial set-ups, daily source checks, and control charting were performed according to the requirements of HDP-PR-HP-416, *Operation of the Ludlum 2221 for Final Status Survey*.

#### 6.1.2 GWS Performance

All GWS measurements on the excavation floor and sidewalls collected with the NaI detector(s) were connected to a Trimble DGPS and with a hand-held data logger. The logging frequency in the survey unit was 1 GWS measurement per second. Each gross gamma measurement is correlated to a set of coordinates based on the Missouri East State Plane, NAD 1983.

The GWS requirements involved moving the NaI detector in a side-to-side fashion no faster than 1 foot per second while holding the probe as close as possible to the excavation surface (nominally 1", but not to exceed 3"). At the same time, the technician was required to slowly advance, causing the detector to trace out a serpentine path over the excavation surface.

FSS Technicians performing GWS in LSA 12-03 used the 4,000 ncpm IAL as a field guide to know when to slow or pause the GWS for more deliberate investigation. If during the GWS, audible count rates noticeably increase above the general area average (i.e., > minimum detectable count rate), FSS Technicians were required to pause momentarily and observe count rates. If sustained count rates approached the IAL, further focused investigation was conducted within the locally elevated area.

To use the IAL effectively, FSS Technicians first determined the local background count rate before starting the GWS. Although the ambient gamma level may vary across the SU due to the geometry and relative distance from contaminated materials in nearby remedial excavations, the average background rate (measured at waist level) within the LSA ranged between 9,000 and 10,000 gross counts per minute (gcpm). Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 13,000 to 14,000 gcpm, FSS Technicians slowed or paused the GWS for more careful investigation of the small areas of elevated activity before deciding if "flagging" a point for potential biased sampling was warranted.

Hard to reach areas, and non-typical areas were surveyed manually as necessary in order to assess the potential for an area of elevated residual activity over 100% of the exposed ground surface.

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After the GWS survey was complete, the GPS/GWS data was reviewed by Radiological Engineering and the Health Physics (HP) Technician performing the survey to determine if possible areas of elevated residual activity remained within the SU that required biased sample investigation. Areas that were flagged by the HP Technician were considered, as well as a statistical evaluation of the GWS data set. The statistical evaluation determined the mean count rate and standard deviation associated with the GWS and then could be used to identify any areas that exceeded 3 standard deviations above the mean. The number of biased samples to be collected and the locations are based on flagged locations exceeding the IAL, the statistical evaluation of the GWS data set, and the professional judgment of Radiological Engineering.

### 6.2 Soil Sampling

# 6.2.1 Systematic Soil Sampling Summary

Table 6-1 provides a summary of systematic sampling by stratum for LSA 12-03.

	Systematic Sam	phile Summary	by Stratam It			
	SU Area,		Systematic			
LSA	planar $(m^2)$	Surface	Root	Deep (Excavation)	QC	
12-03	1,982	8	8	8*	2	

Table 6-1Systematic Sampling Summary by Stratum for LSA 12-03

\*Excavation samples were collected and archived, analysis only required if an overlying Root sample exceeds a 0.5 SOF

# 6.2.2 Systematic Sampling LSA 12-03

Within LSA 12-03, there were 8 systematic locations in which the surface stratum [0 - 15] centimeters (cm)] was sampled in the SU. The underlying root stratum was sampled at all 8 locations. Excavation stratum samples were collected and archived, but were not required to be analyzed since no root stratum sample exceeded a 0.5 Uniform SOF.

Given a planar area of  $1,982 \text{ m}^2$  for LSA 12-03 and an eight - point systematic triangular grid, the point-to-point distance within each row was 16.9 m with spacing of 14.6 m between each of the parallel grid rows within the SU.

While there were eight (8) systematic locations on the LSA 12-03 sampling grid, a total of eighteen (18) samples were collected and analyzed at these locations, including:

- Eight (8) samples collected and analyzed within the surface stratum
- Eight (8) samples collected and analyzed within the root stratum
- Zero (0) samples analyzed within the excavation, or "deep" stratum
- Two (2) Quality Control (QC) field replicate

Figure 6-1 presents the map of the eight systematic sample locations which were sampled within LSA 12-03. The inset table notes the location coordinates (Missouri East, North American Datum (NAD) 1983) and collection intervals for each systematic location.

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	Figure 6-1 LSA 12-03 Systematic Soil Sample Locati	ons
	LI2-03-01-P-S-S-00 L12-03-01-P-S-S-00 L12-03-02-P-R-S-00 L12-03-05-P-R-S-00 L12-03-06-P-E-S-00	mple Locations
Sample ID	Start         End         Northing         Easting           Depth         Depth         (feet)         (feet)	LSA 12-03 1982 m <sup>2</sup> Planar Area
L12-03-01-P-5-5-0 L12-03-02-P-R-5-0 L12-03-03-P-E-5-0 L12-03-04-P-5-5-0	59         65         865475         827580         L12-03-07-P-S-00         L12-03-11-           0         6         865475         827635         L12-03-08-P-R-S-00         L12-03-12-           12-03-08-P-R-S-00         L12-03-12-         L12-03-08-P-R-S-00         L12-03-12-	P-R-S-00
L12-03-05-P-R-S-0 L12-03-06-P-E-S-0 L12-03-07-P-S-S-0 L12-03-08-P-R-S-0	59         65         865475         827635           0         6         865427         827608           6         59         865427         827608	L12-03-16-P-S-S-00 L12-03-17-P-R-S-00 L12-03-18-P-E-S-00
L12-03-09-P-E-S-0 L12-03-10-P-S-S-0 L12-03-11-P-R-S-0 L12-03-12-P-E-S-0	0         6         865427         827663           6         59         865427         827663           59         65         865427         827663	
112-03-13-P-5-5-0 112-03-14-P-R-5-0 112-03-15-P-E-5-0 112-03-16-P-5-5-0	6         59         865379         827691           59         65         865379         827691           0         6         865379         827746	
L12-03-17-P-R-S-0 L12-03-18-P-E-S-0 L12-03-19-P-S-S-0 L12-03-20-P-R-S-0	6         59         865379         827746           59         65         865379         827746           0         6         865331         827719	P-E-S-00 L12-03-24-P-E-S-00
L12-03-21-P-E-S-C L12-03-22-P-S-S-C L12-03-23-P-R-S-C	59         65         865331         827719           0         6         865331         827774           6         59         865331         827774	
L12-03-24-P-E-S-0 L12-03-13-P-S-Q-0		60 90 120 Feet

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Figure 6-2 below presents a tabular listing of all FSS samples collected within LSA 12-03 with associated IDs, sample types, collection intervals, coordinates, and notes.

Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development							
Hematite Decommissioning Project			Revision: 10	Appendix P-4, Page 1 of			
		ESS SAMDI	E & MEASUD	APPENDIX P		OORDINATES	
Survey Area:	LSA		LE & MEASUR	Description:	ATIONS & C		s Open Land Area
Survey Unit:	0.	3	-	Description:		South Eastern S	Survey Unit in "Area 9"
Survey Type:	FS	S	-	Classificatio	1:		Class 1
			T				
Measurement or Sample ID	Surface or CSM	Туре	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes
L12-03-01-P-S-S-00	Uniform	S	428.2	427.7	865475	827580	Surface 6-inch grab
L12-03-02-P-R-S-00	Uniform	S	427.7	423.3	865475	827580	Root 59-inch composite
L12-03-04-P-S-S-00	Uniform	S	430.0	429.5	865475	827635	Surface 6-inch grab
L12-03-05-P-R-S-00	Uniform	S	429.5	425.1	865475	827635	Root 59-inch composite
L12-03-07-P-S-S-00	Uniform	S	427.6	427.1	865427	827608	Surface 6-inch grab
L12-03-08-P-R-S-00	Uniform	S	427.1	422.7	865427	827608	Root 59-inch composite
L12-03-10-P-S-S-00	Uniform	S	430.1	429.6	865427	827663	Surface 6-inch grab
L12-03-11-P-R-S-00	Uniform	S	429.6	425.1	865427	827663	Root 59-inch composite
L12-03-13-P-S-S-00	Uniform	S	429.2	428.7	865379	827691	Surface 6-inch grab
L12-03-14-P-R-S-00	Uniform	S	428.7	424.3	865379	827691	Root 59-inch composite
L12-03-16-P-S-S-00	Uniform	S	430.1	429.6	865379	827746	Surface 6-inch grab
L12-03-17-P-R-S-00	Uniform	S	429.6	425.1	865379	827746	Root 59-inch composite
L12-03-19-P-S-S-00	Uniform	S	428.7	428.2	865331	827719	Surface 6-inch grab
L12-03-20-P-R-S-00	Uniform	S	428.2	423.8	865331	827719	Root 59-inch composite
L12-03-22-P-S-S-00	Uniform	S	430.0	429.5	865331	827774	Surface 6-inch grab
L12-03-23-P-R-S-00	Uniform	S	429.5	425.1	865331	827774	Root 59-inch composite
L12-03-13-P-S-Q-00	Uniform	Q	429.2	428.7	865379	827691	Surface 6-inch grab
L12-03-20-P-R-Q-00	Uniform	Q	428.2	423.8	865331	827719	Root 59-inch composite
L12-03-25-P-S-B-00	Uniform	В	430.0	429.5	865441.8	827667.4	Biased 6-inch grab
L12-03-26-P-S-B-00	Uniform	В	430.0	429.5	865304.7	827779.9	Biased 6-inch grab

Figure 6-2 FSS Sample Locations and Coordinates for LSA 12-03

Green shaded samples are the samples at each sample location, for use in WRS Test.

\*Elevations are in feet above mean sea level.

\*\* Missouri - East State Plane Coordinates [North American Datum (NAD) 1983]

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R

CSM: Three-Layer (Surface-Root-Excavation) or Uniform DCGLs used

Type: Systematic = S, Biased = B; QC =Q; Investigation = I

Quality Record

Hematite	FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12,			
Decommissioning	Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)			
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#### 6.3 Biased Soil Sampling

As discussed in FSSFR Volume 3, Chapter 1, Section 6.1.3, there are three key methods for identifying areas for biased soil sampling, the IAL, the Z-score of the FSS GWS, and the professional judgment of the HP Staff. For LSA 12-03 two (2) biased sample locations were selected within the SU based on the evaluation of the GWS survey data and HP Technician professional judgment. These biased locations represented the two maximum GWS measurements encountered within the SU. Biased samples are collected at the prescribed location to a depth of 6 inches below the exposed ground surface.

#### 6.4 Judgmental/Sidewall Sampling for Tc-99

As an un-excavated SU, no Tc-99 sidewall sampling was necessary for LSA 12-03.

#### 6.5 Quality Control Soil Sampling

Two QC field duplicate sample point were randomly selected and collected at systematic locations L12-03-13 and L12-03-20 for LSA 12-03.

#### 7.0 FINAL STATUS SURVEY RESULTS LSA 12-03

#### 7.1 Gamma Walkover Survey

Post-processed GPS coordinate data is accurate to within  $\pm 0.1$  m for the handheld GPS models used during the GWS. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same GPS location during the walkover, the most elevated radiological measurements are plotted "on top" (e.g. if any sidewalls featured more elevated readings than the floor directly below, the sidewall radiological measurements would overlie the lower floor readings).

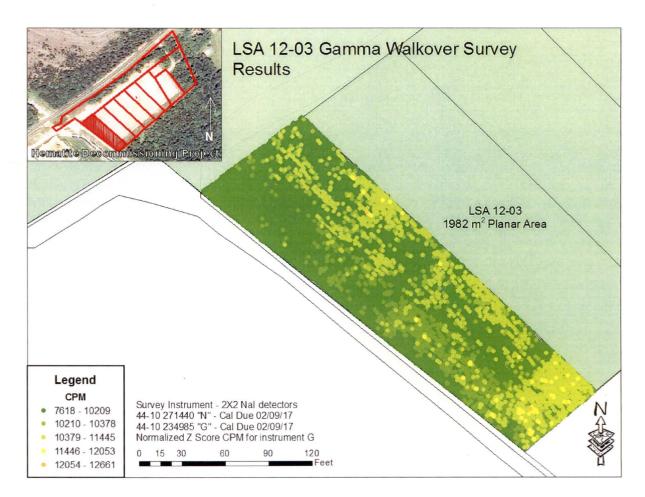
GWS measurements were collected in LSA 12-03 between May 6, 2016, and May 15, 2016.

#### 7.1.1 GWS Results for LSA 12-03

For LSA 12-03, GWS count rates ranged between 7,618 gcpm and 12,661 gcpm, with a mean count rate of 9,621 gcpm. The median count rate was 10,140 gcpm and the standard deviation was 608 cpm. Figure 7-1 below presents a map of the complete GWS data set.

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Figure 7-1 Colorimetric GWS Plot for LSA 12-03

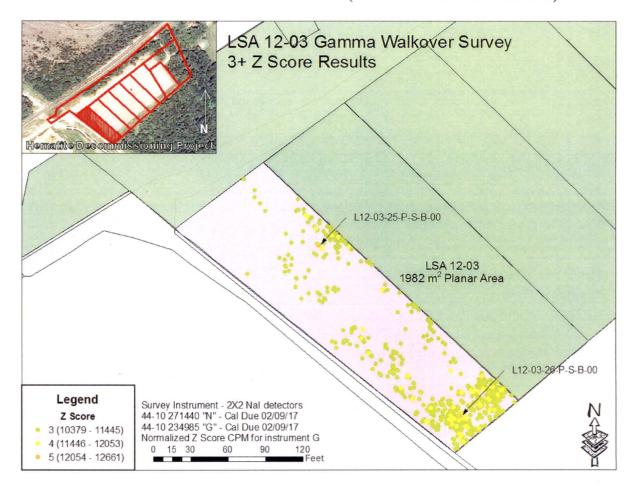


An evaluation of the entire GWS data set was performed to evaluate those small areas of elevated activity which exceeded three (3) standard deviations above the GWS mean measurement, (i.e., "+3 Z-score"). Two locations, L12-03-25 and L12-03-26, were selected for biased sample collection. These biased locations represented the maximum GWS measurements encountered within the SU.

Figure 7-2 below presents a map of the +3 Z-score GWS measurements within LSA 12-03, including the selected biased sampling locations (ID: L12-03-25-P-S-B-00 and L12-03-26-P-S-B-00).

licillatile	FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12, Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)								
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Figure 7-2 Colorimetric GWS Plot for LSA 12-03 (Measurements > Z-score of 3)



All GWS data collected in LSA 12-03 was datalogged and post-processed in Graphical Information Software (GIS).

### 7.1.2 GWS Coverage Results LSA 12-03

FSSFR Volume 3, Chapter 1, Section 6.1.4, *Exposed Surfaces versus Accessible Surfaces*, provides a discussion and the criteria for evaluating the GWS coverage of a SU during FSS.

The post survey processing of the GPS data indicated that although 100% of accessible areas underwent GWS the GWS covered 99.63% of the SU (see Table 7-1). As the evaluation indicates that the GPS coverage exceeded 95% with no readings approaching or exceeding the IAL of 4,000 net cpm in the vicinity of any apparent GPS coverage gaps, the GWS coverage for the SU has been evaluated to meet the intent of the "100% GWS coverage" requirement.

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Table 7-1GWS Gap Analysis LSA 12-03

	Total SU	GWS Gap	Gap	GWS	MARSSIM
	Pixels	Pixels	Percentage	Coverage	Class
LSA 12-03	153,373	574	0.37	99.63	. 1

#### 7.2 Soil Sample Results LSA 12-03

Appendix A presents the analytical results and associated statistics for all FSS surface samples collected within LSA 12-03.

#### 7.2.1 Surface Soil Sample Results LSA 12-03

There were eight systematic samples collected within the surface stratum (0 - 15 cm) of LSA 12-03. Additionally one QC sample and two biased samples were collected in the topmost layer of soil. The maximum Uniform SOF result for the surface samples was 0.22.

# 7.2.2 Subsurface Soil Sample Results LSA 12-03

There were eight systematic locations within LSA 12-03 where root stratum composite sampling was necessary. The root stratum zone is between 0.15 and 1.50 m below final grade surface. At each of the eight root stratum composite sampling locations, the top six inches (1.50 - 1.65 m below final grade surface) of the underlying excavation stratum was also collected and archived, however these excavation samples were not required to be analyzed as no overlying root stratum sample exceeded a 0.5 SOF. The maximum SOF result of the subsurface samples collected in LSA 12-03 was 0.33.

#### 7.2.3 WRS Evaluation

Per Step 7.8.3 of HDP-PR-FSS-721 *Final Status Survey Data Evaluation*, the Wilcoxon Rank Sum (WRS) statistical test was not required for LSA 12-03 since the difference between the maximum SU data set gross SOF and the minimum background area SOF was less than one using the Uniform Stratum criteria. However, for illustrative purposes, the WRS evaluation was still performed for LSA 12-03. All systematically collected samples regardless of depth are used to perform the WRS Test, however biased and QC sample results are not utilized in the WRS Test. The 16 systematically collected samples in LSA 12-03 were ranked against the adjusted activity concentrations of the 32 samples collected within the Background Reference Area. The SU passed the WRS Test since the ranked sum of the reference area ranks, or test statistic  $W_R$ , (1040) was greater than the critical value (860) for the test. As such, the null hypothesis that the SU average concentration is greater than the DCGL<sub>W</sub> was rejected. The WRS evaluation is also included in Appendix A.

# 7.2.4 Graphical Data Review LSA 12-03

Table 7-2 below presents summary results for the all systematically collected samples (includes surface, and root, but not biased or QC samples) collected within LSA 12-03, and the associated

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SOF when compared to the Uniform Stratum  $DCGL_ws$ . The arithmetic average concentration resulted in a SOF of 0.08.

Statistic	Ra-226 DCGL = 1.9 BKG = 1.07 (pCi/g)	Tc-99 DCGL = 25.1 (pCi/g)	Th-232 DCGL = 2.0 BKG = 1.0 (pCi/g)	U-234 DCGL=195.4 (pCi/g)	U-235 DCGL=51.6 (pCi/g)	U-238 DCGL=168.8 (pCi/g)	Sample SOF (Uniform DCGL)
Average	0.054	0.195	0.057	1.841	0.060	1.064	0.08
Minimum	0.00 ( <bkg)< td=""><td>0.07</td><td>0.00 (<bkg)< td=""><td>0.194</td><td>-0.131</td><td>0.492</td><td>0.01</td></bkg)<></td></bkg)<>	0.07	0.00 ( <bkg)< td=""><td>0.194</td><td>-0.131</td><td>0.492</td><td>0.01</td></bkg)<>	0.194	-0.131	0.492	0.01
Maximum	0.270	0.450	0.350	4.858	0.268	1.470	-0.33

<b>Table 7-2</b>	
LSA 12-03 FSS Sample Data Summary and Calculated SOF Values (Systematic)	)

Notes:

1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g, Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.

2. Average SOF for data set calculated using average radionuclide concentrations.

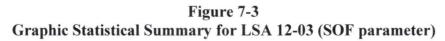
3. U-234 values are inferred from the U-235/U-238 ratio.

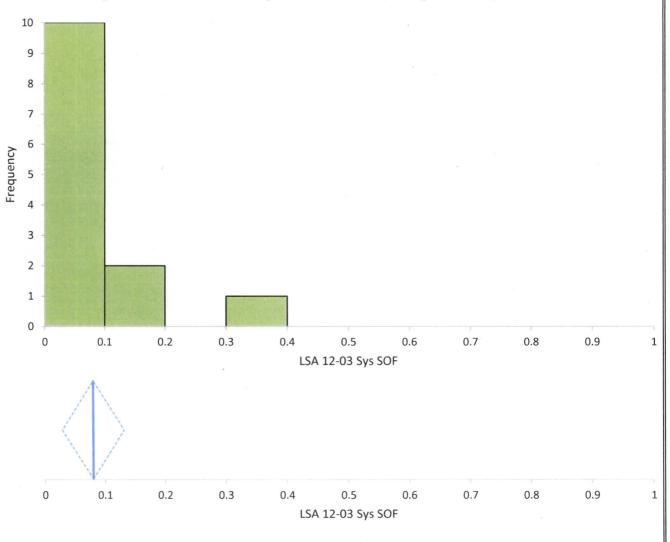
Section 8.2.2.2 of MARSSIM recommends a graphical review of FSS analytical data, to include at a minimum, a posting plot and a histogram. A frequency plot, or histogram, is a useful tool for examining the general shape of a data distribution. This plot is a bar chart of the number of data points within a certain range of values. The frequency plot will reveal any obvious departures from symmetry, such as skewness or bimodality (two peaks), in the data distribution for the survey unit. The presence of two peaks in the survey unit frequency plot may indicate the existence of isolated areas of residual radioactivity.

Figure 7-3 presents the overall statistical metrics for the SOF parameter for the 16 systematically collected samples from LSA 12-03. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 12-03. The middle graph presents the mean SOF (0.08 as indicated by the blue vertical line) of the sample population and the 95% confidence interval of the mean SOF represented by the blue diamond which is 0.03 to 0.13. The 97.75% confidence interval based on the median (0.05) of the sample results is 0.02 to 0.12. The bottom two charts present the various statistical metrics of the LSA 12-03 SOF data set, including the mean, median, standard deviation, minimum, maximum, confidence intervals, etc.

Figure 7-3 exhibits no unusual symmetry or bimodality concerns for the LSA 12-03 data associated with the systematically collected measurement locations.

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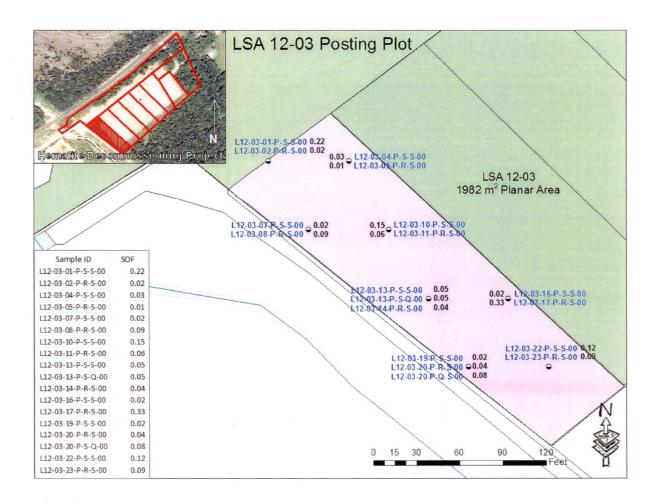
N 13

	Mean	95%	6 CI	Mean SE	SD	Variance	Skewness	Kurtosis	
LSA 12-03 Sys SOF	0.08	0.03	to 0.13	0.024	0.09	0.01	2.3	6.01	5
	Minimum	1st quartile	Median	97.75	% CI	3rd quartile	Maximum	IQR	
LSA 12-03 Sys SOF	0.01	0.02	0.05	0.02	to 0.12	0.10	0.3	0.08	

riciliatile	FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12, Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)								
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A posting plot is simply a map of the SU with the data values (in this case the SOF values for each systematically collected sample) entered at the measurement locations. This potentially reveals heterogeneities in the data – especially possible patches of elevated residual radioactivity. The posting plot for LSA 12-03 is presented below in Figure 7-4. Figure 7-4 shows no unusual patterns in the data.

Figure 7-4 Posting Plot for LSA 12-03 Systematic Measurement Locations



Appendix A to this report presents the complete analytical data set (in Microsoft Excel format) used to derive the summary statistics presented in Table 7-2, Figure 7-3, and Figure 7-4 above. A summary of the analytical data is presented in Table 7-3 below. Appendix O to this report presents the TestAmerica Analytical Laboratory soil sample reports.

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		Ô													TestAr	nerica A	nalytic	al Result	s														
	(ft)	Ő	TestAmerica Analytical Results										1.1.1																				
<u> </u>	pth	Bias			Ra-	226					Tc-99					Th-	232			1	nferred	U-234			U-2				U-2	38		Enr.	SOF
Sample ID	Sample Depth (ft)	Type (Systematic, Bi	Result	Uncertainty	MDC	Qualifier	Net Result*	orrected Result	Result	orrected Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Net Result**	orrected Result	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Enrichment (%)	SOF
_12-03-01-P-S-S-00	0.00	S	1.330	0.205	0.084	N/A	0.260	0.260	0.450	0.450	0.094	0.247	N/A	1.060	0.197	0.133	N/A	0.060	0.060	3.972	NA	NA	NA	0.216	0.208	0.259	U	1.470	0.678	1.020	N/A	2.3	0.22
12-03-01-P-S-S-00	0.00	S	1.050	0.145	0.061	N/A	-0.020	0.000	0.093		0.032	0.252	U	5 2015	0.152			0.000	0.000	1.421	NA	NA	NA	0.073	0.282	0.468	U	0.981	0.494	0.764	N/A	1.2	0.02
12-03-04-P-S-S-00	0.00		0.900	0.153	0.079	N/A	-0.170	0.000	0.405		0.108	0.232	N/A		0.190	0.129	N/A	0.010		0.194	NA	NA	NA	0.004	0.374	0.625	U	0.904	0.355	0.918	U	0.1	0.02
12-03-05-P-R-S-00	0.50	S	0.957	0.132	0.059	N/A	-0.113	0.000	0.007		0.075	0.234	U	0.935	0.143	0.082	N/A	-0.065	0.000	1.210	NA	NA	NA	0.000	0.116	0.517	U	1.210	0.674	0.833	N/A	0.7	0.01
12-03-07-P-S-S-00	0.00	S	1.060		0.072	N/A	-0.010	0.000	0.273		0.094	0.233	N/A			0.151	N/A	-0.023	0.000	1.503	NA	NA	NA	0.082	0.189	0.315	U	0.492	0.238	1.160	U	2.6	0.02
.12-03-08-P-R-S-00	0.50	S	1.180	0.184	0.088	N/A	0.110	0.110	0.007		0.044	0.242	U	1.050	0.211	0.139	N/A	0.050	0.050	0.367	NA	NA	NA	0.008	0.068	0.687	U	1.350	0.652	0.991	N/A	0.1	0.09
12-03-10-P-S-S-00	0.00	S	1.130	0.160	0.075	N/A	0.060	0.060	0.366	0.366	0.154	0.246	N/A	1.180	0.175	0.130	N/A	0.180	0.180	1.210	NA	NA	NA	-0.131	0.613	0.549	U	1.210	0.534	0.810	N/A	0.7	0.15
12-03-11-P-R-S-00	0.50	S	1.090	0.176	0.082	N/A	0.020	0.020	0.231	0.231	0.083	0.246	U	1.020	0.188	0.101	N/A	0.020	0.020	3.383	NA	NA	NA	0.184	0.148	0.200	U	1.240	0.596	0.907	N/A	2.3	0.06
12-03-13-P-S-S-00	0.00	S	1.070	0.147	0.056	N/A	0.000	0.000	0.394	0.394	0.053	0.233	N/A	0.898	0.141	0.089	N/A	-0.102	0.000	4.858	NA	NA	NA	0.268	0.150	0.183	N/A	1.140	0.307	0.739	N/A	3.6	0.05
12-03-14-P-R-S-00	0.50	S	1.070	0.168	0.081	N/A	0.000	0.000	0.161	0.161	0.041	0.237	U	1.040	0.202	0.128	N/A	0.040	0.040	1.429	NA	NA	NA	0.074	0.129	0.658	U	0.954	0.357	0.829	N/A	1.2	0.04
12-03-16-P-S-S-00	0.00	S	1.060	0.146	0.061	N/A	-0.010	0.000	0.031	0.031	0.083	0.236	U	1.020	0.155	0.109	N/A	0.020	0.020	0.805	NA	NA	NA	-0.126	0.176	0.536	U	0.805	0.476	0.746	N/A	0.7	0.02
12-03-17-P-R-S-00	0.50	S	1.340	0.202	0.078	N/A	0.270	0.270	0.081	0.081	0.062	0.239	U	1.350	0.253	0.117	N/A	0.350	0.350	0.833	NA	NA	NA	-0.123	0.297	0.680	U	0.833	0.346	0.981	U	0.7	0.33
12-03-19-P-S-S-00	0.00	S	0.853	0.122	0.052	N/A	-0.217	0.000	0.230	0.230	0.040	0.221	N/A	0.902	0.140	0.094	N/A	-0.098	0.000	1.166	NA	NA	NA	0.060	0.123	0.306	U	0.850	0.258	0.646	N/A	1.1	0.02
12-03-20-P-R-S-00	0.50	S	1.040	0.152	0.078	N/A	-0.030	0.000	0.058		0.065	0.231	U	1.040	0.182	0.153	N/A	0.040	0.040	1.567	NA	NA	NA	0.083	0.225	0.375	U	0.880	0.521	0.814	N/A	1.5	0.04
12-03-22-P-S-S-00	0.00	S	1.110	0.156	0.069	N/A	0.040	0.040	0.268		0.040	0.239	N/A	1.140	0.185	0.089	N/A	0.140	0.140	1.842	NA	NA	NA	0.094	0.192	0.513	U	1.440	0.536	0.796	N/A	1.1	0.12
12-03-23-P-R-S-00	0.50	S	1.180	0.191	0.099	N/A	0.110	0.110	0.064		0.056	0.227	U	0.916	0.230	0.155	N/A	-0.084	0.000	3.700	NA	NA	NA	0.202	0.171	0.238	U	1.260	0.639	0.981	N/A	2.5	0.09
12-03-13-P-S-Q-00	0.00	Q	1.070	0.161	0.070	N/A	0.000	0.000	0.560		0.176	0.227	N/A	0.954	0.172	0.107	N/A	-0.046	0.000	3.622	NA	NA	NA	0.196	0.120	0.169	N/A	1.470	0.579	0.856	N/A	2.1	0.05
12-03-20-P-R-Q-00	0.50	~	0.866	0.144	0.078	N/A	-0.204	0.000	0.061		0.044	0.244	U	1.120	0.217	0.135	N/A	0.120	0.120	1.395	NA	NA	NA	0.069	0.274	0.458	U	1.250	0.589	0.894	N/A	0.9	0.08
12-03-25-P-S-B-00	0.00	В	0.828	0.147	0.084	N/A	-0.242	0.000	0.636		0.129	0.234	N/A		0.183	0.142		0.110		3.083	NA	NA	NA	0.168	0.161	0.213	U	1.070	0.346	0.867	N/A	2.4	0.11
12-03-26-P-S-B-00	0.00	В	1.080	0.160	0.067	N/A	0.010	0.010	0.320	0.320	0.067	0.225	N/A	1.140	0.223	0.121	N/A	0.140	0.140	6.703	NA	NA	NA	0.370	0.166	0.190	N/A	1.460	0.550	0.801	N/A	3.8	0.14
Systematic Min					0.0	000				1	0.007					0.0					0.19	94			-0.1	31			0.49	92		1.6	0.01
Systematic Max					0.2						0.450					0.3					4.8				0.2				1.47			ent	0.33
Systematic M Systematic Me					0.0						0.195					0.0					1.84				0.0				1.06			Average Enrichment (%)	0.08
Systematic Standard	and the state of t	n			0.0						0.196					0.0		. –			1.42				0.0		0.268				Enr	0.05	
Systematic Standard	Deviatio		With in	growth, u	0.0 se Ra226			1.07			0.153			Th232	bkg =	0.0					1.37	12			0.13	21			0.26	00			0.09

Table 7-3

NOTES:

Gross results in units of pCi/g.

\* Background with ingrowth (1.07 pCi/g) subtracted from gross result.

\*\*Background (1.0 pCi/g) subtracted from gross result.

U Qualifier: Result is less than the sample detection limit.

All uncertainty values are reported at the 2-sigma confidence level.

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# 7.2.5 Biased Soil Sample Result LSA 12-03

Two (2) biased samples were collected from LSA 12-03. The sample collected at location L12-03-26 represented the maximum GWS measurement (12,661 gcpm) within the SU, and had a result of 0.14 Uniform SOF.

#### 7.2.6 Quality Control Soil Sample Result LSA 12-03

Two QC field duplicate sample points were randomly selected for LSA 12-03 which were collected at systematic locations L12-03-13 and L12-03-20.

For the 18 samples (i.e., 16 systematic + 2 biased) collected within LSA 12-03, two field duplicate samples were collected. This frequency equates to 11.1%, (i.e. 2/18). Form HDP-PR-FSS-703-1 documents that the duplicate sample result comparison with the partner's sample results that all comparison criteria were less than the calculated warning limits (see Figure 7-5 below).

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	Form I	IDP-PR-FS	S-703-1 F	ield D	Figure 7- uplicate Sa		ssessment I	LSA 12-(	)3 (1 of 2	2)	<u>.                                    </u>	<u>I</u>
Hematite	Procedure: HDP-PI	R-FSS-703, Fin	al Status Sur	vey Qua	lity Control							
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			FIE		ORM HDP- PLICATE SA		03-1 ASSESSMENT			· · · · ·	<u></u>	
urvey Unit No.:	LSA 12-03						Class 1 Laydow	n Land Are	a in "Area	13"		
Sample ID	Field Duplicate Sample ID	Radionuclide	Sample (p		Field Duplica (pCi/ Activity (x <sub>i</sub> )		Average Activity $(\bar{\chi})$ (pCi/g)	Nuclide DCGL (pCi/g)	Statistic <sup>2</sup>	Warning Limit	Control Limit	Statistic Exceeds Limit? (Y/N)
	L12-03-13-P-S-Q-00	Ra-226	1.07	0.0557	1.07	0.0703	1.070	1.9	0	0.269	0.403	N
.12-03-13-P-S-S-00	L12-03-13-P-S-Q-00	Tc-99	0.394	0.233	0.56	. 0.227	0.477	25.1	0.166	3.552	5.321	N
.12-03-13-P-S-S-00	L12-03-13-P-S-Q-00	Th-232	0.898	0.0889	0.954	0.107	0.926	2.0	0.056	0.283	0.424	N
.12-03-13-P-S-S-00	L12-03-13-P-S-Q-00	U-234 <sup>1</sup>	4.858	N/A	3.622	N/A	4.240	195.4	1.236	27.649	41.425	N
.12-03-13-P-S-S-00	L12-03-13-P-S-Q-00	U-235	0.268	0.183	0.196	0.169	0.232	51.6	0.072	7.301	10.939	N
.12-03-13-P-S-S-00	L12-03-13-P-S-Q-00	U-238	1.14	0.739	1.47	0.856	1.305	168.8	0.330	23.885	35.786	N
	nt is not necessary if th		-	MDC.		·	Reviewed by:	1.) (	Last &	- days /		
Performed by: 7 <u>6</u>	omas Jacdy	-ph-1					Reviewed by:		1 alan v	wersy.	000	<u>nan</u>
Date:	11-23-16				,		Date: 11/ 7	23/16				
Quality Record								·				

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	Form H	IDP-PR-FS	5S-703-1 F	ield D	Figure 7- Puplicate Sa		ssessment L	SA 12-0	3 (2 of 2	:)		
Hematite	Procedure: HDP-PR	-FSS-703, Fin	al Status Sur	vey Qua	lity Control				,			
Decommissioning Project							· .	Revisi	on: 2		Page 1	of 1
	<u> </u>		FIE		ORM HDP-I PLICATE SA		)3-1 SSESSMENT			<u> </u>		
urvey Unit No.:	LSA 12-03						Class I Laydow	n Land Are	a in "Area	13"		
Sample ID	Field Duplicate Sample ID	Radionuclide	Sample (p Activity (x.)		Field Duplica (pCi/ Activity (x <sub>i</sub> )	-	Average Activity ( $\bar{\chi}$ ) (pCi/g)	Nuclide DCGL (pCi/g)	Statistic <sup>2</sup>	Warning Limit	Control Limit	Statistic Exceeds Limit? (Y/N)
_12-03-20-P-R-S-00	L12-03-20-P-R-Q-00	Ra-226	1.04	0.0783	0.866	0.0782	0.953	1.9	0.174	0.269	0.403	N
.12-03-20-P-R-S-00	L12-03-20-P-R-Q-00	Tc-99	0.0577	0.231	0.0609	0.244	0.059	25.1	NA	3.552	5.321	NA
.12-03-20-P-R-S-00	L12-03-20-P-R-Q-00	Th-232	1.04	0.153	1.12	0.135	1.080	2.0	0.080	0.283	0.424	N
.12-03-20-P-R-S-00	L12-03-20-P-R-Q-00	U-234 <sup>1</sup>	1.567	N/A	1.395	N/A	1.481	195.4	0.171	27.649	41.425	N
_12-03-20-P-R-S-00	L12-03-20-P-R-Q-00	U-235	0.0827	0.375	0.0692	0.458	0.076	51.6	NA	7.301	10.939	NA
.12-03-20-P-R-S-00	L12-03-20-P-R-Q-00	U-238	0.88	0.814	1.25	0.894	1.065	168.8	0.370	23.885	35.786	N
	to MDC available. In the not necessary if the $\frac{7}{2} \circ \cos s = \frac{1}{2} \cos s + \frac{1}{2} \sin s + \frac{1}{2}$		-	4DC.			Reviewed by:	WC	lash E	Nas	IW.	al
Date: //	- 2 3 · 16						Date: ///23	5/16				

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#### 7.3 Tc-99 Hot Spot Assessment LSA 12-03

There is no historical sampling data available for this area since it was always considered a nonimpacted area prior to the storage of potential reuse soils within the LSA. As a previously nonimpacted area there is no history of a Tc-99 sample result ever exceeding the Tc-99 Uniform  $DCGL_w$ , as only potential reuse soil was placed within the LSA. The highest Tc-99 sample result collected from both Final RASS and FSS was 2.42 pCi/g. Therefore there is no concern for a potential Tc-99 hot spot exceeding the  $DCGL_w$  of 25.1, and there is no reason to perform a Tc-99 hot spot assessment.

## 8.0 ALARA EVALUATION LSA 12-03

All samples collected within LSA 12-03 were evaluated against the Uniform Stratum DCGL<sub>w</sub>. For LSA 12-03 no sample result exceeded a SOF of 1.0. The average SOF result, based on all systematically collected samples, was 0.08 for LSA 12-03. The average SOF equates to residual activity contributions from the survey unit area of 2.0 mrem/yr for LSA 12-03. Groundwater Monitoring Well data provided in FSSFR Volume 6, Chapters 2 and 3 {ML16287A528}, and Chapter 4 {ML16342B552}, indicate that the groundwater dose contribution will be a fraction of the MCLs. Nevertheless, a maximum groundwater contribution assumption of 4.0 mrem/yr based upon the U.S. Environmental Protection Agency (EPA) MCLs will be added to the total estimated dose for LSA 12-03. Adding these dose contributions together, the total estimated dose for LSA 12-03 is 6 mrem/yr.

Since the estimated Total Effective Dose Equivalent is well below the regulatory release criterion of 25 mrem/yr, the conclusion of the ALARA evaluation is that the FSS of LSA 12-03 was successful and that there would be no discernable benefit to the health and safety of the public in attempting to further reduce the results of FSS by performing remediation of LSA 12-03.

#### 9.0 FSS PLAN DEVIATIONS LSA 12-03

#### 9.1 Remedial Actions during FSS

There was no remedial action after FSS in LSA 12-03.

#### 9.2 Adjustments to Scan MDC Calculations

Scan MDCs for LSA 12-03 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD- FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. The assumed LSA background count rate of 9,000 cpm was applied to determine the prospective Scan MDCs, and the actual mean count rate from the FSS survey was 9,621 cpm. Therefore the calculated Scan MDCs are appropriate, and no adjustments need to be made.

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# 10.0 DATA QUALITY ASSESSMENT

The Data Quality Objective (DQO) process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process are presented in Volume 3, Chapter 1, Section 4.0 of the FSSFR and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

# 10.1 Data Quality Assessment for LSA 12-03

The Data Quality Assessment of the survey methodology, sampling and sample analysis results, and the Quality Control sampling and analysis results to ascertain the validity of the conclusion for LSA 12-03 (see Figure 10-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-416 (*Operation of the Ludlum 2221 for Final Status Survey*).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.
- The systematic samples that were collected (on a random-start triangular grid) and the gamma scan surveys that were conducted were performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.
- All samples sent for analysis at the approved offsite laboratory (TestAmerica) were tracked on a chain of custody form in accordance with HDP-PR-QA-006, *Chain of Custody*.
- Quality Control sample results were verified to meet the acceptance criteria as specified in HDP-PR-FSS-703, *Final Status Survey Quality Control.*
- LSA 12-03 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.
- The WRS Test is not necessary when the difference between the maximum survey unit data set measurement SOF and the minimum background area measurement SOF is less than or equal to one. For LSA 12-03, no individual gross SOF result in the FSS data set exceeded the SOF of the minimum background reference area measurement by more than one using the Uniform Stratum criteria. Therefore, the WRS Test was not required for LSA 12-03. However, the WRS Test was still performed for illustrative purposes. Since the test statistic, WR (1040) exceeded the critical value (860), the FSS data set passed the WRS Test and the null hypothesis was rejected. The WRS Test worksheet is presented in Appendix A.
- Two biased soil samples were collected from the locations of the highest gamma count rate within the SU, with a maximum result of 0.14 Uniform SOF.

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- The maximum SOF result for all surface samples within LSA 12-03 was 0.22. The maximum SOF result for all subsurface samples within LSA 12-03 was 0.33. The average SOF result for all systematically collected samples within LSA 12-03 was 0.08, with an upper 95% confidence level (UCL<sub>mean</sub> 0.95) of 0.13.
- No FSS sample result in LSA 12-03 exceeded a SOF of 1.0 as compared to the Uniform Stratum criteria, therefore an elevated measurement comparison (EMC) or supplemental investigations was not required. For the same reason, no comparisons to the alternate "Three-Layer" multi-CSM (i.e. Surface, Root and Excavation) DCGLs were necessary.
- A retrospective sampling frequency evaluation was performed to determine if sufficient statistical power exists to reject the null hypothesis based on the total number (8) of systematic samples actually collected within LSA 12-03. The successful result of the retrospective power evaluation presented in Table 10-1 for LSA 12-03 indicates that the minimum number of samples required (8) for the WRS Test were equal to the number of sampling locations actually collected The methodology used for the retrospective sampling within LSA 12-03. frequency evaluation is similar to the prospective sample size determination performed during FSS Plan Development except that actual FSS sample results and statistics are used in the sample size verification. Specifically, the mean and standard deviation of the eight LSA surface samples (i.e., the WRS Test sample data set) are used to derive the relative shift for each LSA. Given the HDP Type I and Type II errors of 0.05 and 0.10, respectively, the calculated relative shift is then correlated to a minimum sample size number as provided in Table 5-1 of MARSSIM.
- HDP staff ensured that a visual inspection of the SU configuration and of the Isolation & Control measures were performed periodically, and confirmed that there were no instances of potential cross contamination from weather events until the FSS of all remaining areas at HDP were completed.

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	Table	e 10-1	
Retrospective	Sample Size	Verification	for LSA 12-03

Uniform DCGL Criteria Evaluation						
N/2 Value Verification						
SOF (Ra/Tc/Th/Iso U)						
0.09						
1						
0.08						
0.92						
10.59						
1.000000						
12						
14.4						
8						
8						
SUFFICIENT MEASUREMENTS						

"N/2" Corresponds to the number of survey unit measurement locations required for the WRS Test

MARS	SIM Table 5.1
Δ/σ	Pr
0.1	0.528182
0.2	0.556223
0.3	0.583985
0.4	0.611335
0.5	0.638143
0.6	0.664290
0.7	0.689665
0.8	0.714167
0.9	0.737710
1.0	0.760217
1.1	0.781627
1.2	0.801892
1.3	0.820978
1.4	0.838864
1.5	0.855541
1.6	0.871014
1.7	0.885299
1.8	0.898420
1.9	0.910413
2.0	0.921319
2.25	0.944167
2.5	0.961428
2.75	0.974067
3.0	0.983039
3.5	0.993329
4.0	0.997658
4.01	1.000000

# MARSSIM Table 5.2, $\alpha = 0.05$ , $\beta = 0.10$

α

$Z_{1-\alpha}$ (or $Z_{1-\beta}$ )
2.576
2.326
2.241
1.960
1.645
1.282
1.036
0.842
0.674
0.524

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# Figure 10-1 Data Evaluation Checklists prepared for LSA 12-03 (page 1 of 2)

	natite hissioning	Procedure: HDP-PR	-FSS-721, Final Statu	is Survey Data Eva	luation		
	Project				Revision:	Appendix G-1, Page 1 of 2	
			APPENDIX (				
	FINAL	STATUS SURVEY	DATA QUALITY O	BJECTIVES REV	IEW CHE	CKL	181
Surv	ey Area:	LSA 12	Description:	Laydown Area, P	lant Soils SI	EA	
	ey Unit:	03		Class 1 Laydown			rea 13"
1	to data ana		analysis results that w ndividually reviewed his procedure?		Yes 🔀	No [	
		the locations specif	nents and/or samples ied in the FSSP and		Yes 🔀	No [	
			performed of the are S Sample Instructions		Yes 🔀	No [	
			and/or samples been to FSSP & the FSS Samp		Yes 🔀	No [	NA [
			nples or measuremen ated as a QC sample?		Yes 🔀	No [	NA
	capable of		measure or analyze or gross activity at a rel?		Yes 🔀	No [	
	analyze da		uments that were use ne of use and were the le source?		Yes 🔀	No [	
			ally response-checked day the data was mea		Yes 🔀	No [	
9.	Do the sam	ples match those ide	ntified on the chain of	f custody?	Yes 🖂	No [	NA [
			t the acceptance criter Survey Quality Contr		Yes 🛛	No [	
		oratory OC paramete	ers within acceptable	limits?	Yes 🖂	No	

Quality Record

.

Hematite Decommissioning Project	FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12, Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)		
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Figure 10-1				
Data Evaluation Checklists prepared for LSA 12-03 (page 2 of 2)				

Hematite	Procedure: HDP	P-PR-FSS-721, Final Status	Survey Data Eval	uation		
Decommissioning Project				Revision: 10	Appendix G-1, Page 2 of 2	
APPENDIX G-1						
FINAL	FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST					
Survey Area:	LSA 12		Laydown Area, F			
Survey Unit:	03	Description:	Class 1 Laydown	Land Area in '	'Area 13"	
Discrepancy:	N/A					
· · ·						
		1				
<u></u>			· · · · · · · · · · · · · · · · · · ·			
Corrective Acti	ions Taken: N/A	X				
	· .					
					<u>.                                    </u>	
11. Have the	corrective actions	resolved the discrepancy v	with the data?	Yes 🗌 No	D 🗌 NA 🖂	
		is form to the RSO.				
		ll be answered by the RSO				
a. If the a still val		11 was "No", then is the a	ffected data	Yes 🗌 No	) 🗌 NA 🕅	
		sting valid measurements c compliance for the survey		Yes 🗌 No	> □ NA 🕅	
		equisition of additional me for the survey unit.	easurements or sam	ples as necessa	ry to	
Prepared by	y (HP Staff):	Thomas Yar Jy (Print Name)	(Signatur	- <u></u>	<u>23-/6</u> (Date)	
Approved b	у (RSO): .	(Print Name)	(Signatur		(Date)	
Quality Record						
Zumity Record					· · · · · · · · · · · · · · · · · · ·	

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# 11.0 CONCLUSION LSA 12-03

An adequate quantity and quality of radiological surveys and samples, as well as the corresponding laboratory analysis has been performed, evaluated and documented to demonstrate that the dose associated with all sources within SU LSA 12-03 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402.

	LSA 12-03 SOF and Dose Summation					
	AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	BURIED PIPING	REUSE SOIL	TOTAL
SOF	0.08	N/A	0.16	N/A	N/A	0.24
DOSE	2.0 mrem/year	N/A	4.0 mrem/year	Ń/A	N/A	6.0 mrem/year

Table 11-1JSA 12-03 SOF and Dose Summation

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# 12.0 FINAL STATUS SURVEY DESIGN LSA 12-04

This section of the report describes the method for determining the number of samples required for the FSS of LSA 12-04 as well as summarizing the applicable requirements of the FSS Plan. These include the  $DCGL_W$ , scan survey coverage, and IAL. The radiological instrumentation used in the FSS of LSA 12-04 and their detection sensitivities are also discussed.

## 12.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 12-04 were driven by the type (Open Land) and Class (Class 1) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development*, November 2015.

#### 12.1.1 Surrogate Evaluation Areas

A discussion of Surrogate Evaluation Areas is given in the FSSFR Volume 3, Chapter 1, Section 5.0, *Final Status Survey Design*.

#### 12.1.2 DCGL<sub>w</sub>

During the FSS design process a review was performed of the RASS data for LSA 12-04. The RASS data was used as confirmation that no known areas of residual radioactivity remained within the SU that exceeded the Uniform Stratum  $DCGL_w$ . Therefore the Uniform Stratum  $DCGL_w$  was selected for use in demonstrating compliance with the release criteria.

#### 12.1.3 GWS Coverage

As a Class 1 SU, LSA 12-04 was required to undergo a 100% GWS.

#### 12.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 12-04 was the Ludlum 44-10 2" x 2" NaI detectors, coupled to a Ludlum 2221 scaler-ratemeter.

#### 12.1.5 Scan Minimum Detectable Concentration

Scan MDCs for LSA 12-04 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD- FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. As background levels were approximately 10,000 cpm within LSA 12-04, the scan MDC calculation for total uranium given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.2.6.d, was applied:

Scan MDC (total uranium) = 
$$\frac{1}{\left(\left(\frac{f_{U-234}}{3659 \ pCi/g}\right) + \left(\frac{f_{U-235}}{2.32 \ pCi/g}\right) + \left(\frac{f_{U-238}}{30.6 \ pCi/g}\right)\right)}$$

Equation 12-1

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To determine isotopic Uranium fractions HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* assumes that the average LSA enrichment is 4% or less. Based on the systematically collected RASS samples in LSA 12-04, the average enrichment for the SU was 2.96%. All other Scan MDC parameters agreed upon between Westinghouse and the NRC were applied (e.g. use of a 2 in air gap, scan rate of 1 ft/sec, 0.75 surveyor efficiency), therefore no subsequent changes to the calculated Scan MDCs need to be made.

Prospectively calculated Scan MDCs for 2" x 2" NaI detectors that were used in LSA 12-04 are shown below:

Table 12-1Scan MDCs for 2" x 2" NaI detector, 10,000 cpm background: LSA 12-04

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 12-04	40.9	46.6	0.87	2.8	1.21	3.0

\*DCGL<sub>w</sub> includes background concentrations of 0.9 pCi/g for Ra-226 (no ingrowth) and 1.0 pCi/g for Th-232. DCGLw values are based on the Uniform Stratum release criteria.

The values in Table 12-1 reflect those presented in the FSS Plan prepared for the SU prior to FSS.

#### 12.1.6 Investigation Action Level

FSSFR Volume 3, Chapter 1, Section 6.1.3, *Investigation Action Level (IAL)*, provides a discussion in regards to the IAL. The basis of the IAL is detailed in HDP memorandum, HEM-15-MEMO-021 "Evaluation of the Scan IAL for Class 1 areas at the Westinghouse Hematite Site". The IAL used during the GWS of LSA 12-04 was established at 4,000 ncpm.

#### 12.1.7 LSA 12-04 FSS Design Summary

The FSS Plan for LSA 12-04 can be found in Appendix I. Table 12-2 presents an overall FSS design and implementation summary for LSA 12-04.

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# **Table 12-2**

FSS Design Summary for LSA 12-04

• • •			
Scan Coverage		100% exposed soil and rock	
		40.9 pCi/g total Uranium (based on a 10,000	
Scan MDC	cpr	cpm background); 0.87 pCi/g Th-232; 1.21	
	pC	pCi/g Ra-226*	
Investigation Action Level (IAL)	4,0	00 net cpm **	
Systematic Sampling Locations:	······································		
Depth	Number of Sample	Comments	
0-15  cm (Surface)	8		
15 cm – 1.5 m (Root)	8	These samples will be taken on a	
> 1.5m (Excavation)	8	random-start systematic grid.	
<b>Biased Survey/Sampling Locations</b>	•		
Sidewall Sampling Locations: A minimum of one (1) discretionary		adiological Engineering.	
A minimum of one (1) discretionary	sidewall sample will be	collected based on the following definition	
A minimum of one (1) discretionary of "sidewall": sidewall candidates for	sidewall sample will be	collected based on the following definition	
A minimum of one (1) discretionary of "sidewall": sidewall candidates for 12" in height. Instrumentation: Ludlum 2221 with 44-10 (2x2 NaI)	sidewall sample will be r sampling must be vertic detector; with Used for	collected based on the following definition al or near vertical (> 45° angle) and at leas or GWS and to obtain static count rates a	
A minimum of one (1) discretionary of "sidewall": sidewall candidates for 12" in height. Instrumentation: Ludlum 2221 with 44-10 (2x2 NaI) collimation for investigations	sidewall sample will be r sampling must be vertic detector; with Used for biased	collected based on the following definition alor near vertical (> 45° angle) and at leas or GWS and to obtain static count rates a measurement locations.	
A minimum of one (1) discretionary of "sidewall": sidewall candidates for 12" in height. Instrumentation: Ludlum 2221 with 44-10 (2x2 NaI) collimation for investigations *Values based on information provi	sidewall sample will be r sampling must be vertic detector; with Used for biased ded in HDP-TBD-FSS-0	collected based on the following definition alor near vertical (> 45° angle) and at leas or GWS and to obtain static count rates a measurement locations. 02, "Evaluation and Documentation of the	
A minimum of one (1) discretionary of "sidewall": sidewall candidates for 12" in height. Instrumentation: Ludlum 2221 with 44-10 (2x2 NaI) collimation for investigations *Values based on information provi Scanning Minimum Detectable Cond	sidewall sample will be r sampling must be vertic detector; with Used for biased ded in HDP-TBD-FSS-0 centrations (MDC) for F	collected based on the following definition alor near vertical (> 45° angle) and at lea or GWS and to obtain static count rates a measurement locations. 02, "Evaluation and Documentation of the inal Status Surveys (FSS). The Scan MD	
A minimum of one (1) discretionary of "sidewall": sidewall candidates for 12" in height. Instrumentation: Ludlum 2221 with 44-10 (2x2 NaI) collimation for investigations *Values based on information provi Scanning Minimum Detectable Cond for total Uranium reflects a conserv	sidewall sample will be r sampling must be vertic detector; with Used for biased ded in HDP-TBD-FSS-0 centrations (MDC) for F ative assumption of 4%	collected based on the following definition cal or near vertical (> 45° angle) and at lead or GWS and to obtain static count rates measurement locations. 02, "Evaluation and Documentation of the inal Status Surveys (FSS). The Scan MD enrichment. The actual RASS enrichment	
A minimum of one (1) discretionary of "sidewall": sidewall candidates for 12" in height. Instrumentation: Ludlum 2221 with 44-10 (2x2 NaI) collimation for investigations *Values based on information provi Scanning Minimum Detectable Cond for total Uranium reflects a conserv (2.0%) would result in Scan MDC va	sidewall sample will be r sampling must be vertic detector; with Used for biased ded in HDP-TBD-FSS-0 centrations (MDC) for F ative assumption of 4% lues slightly less than tho	collected based on the following definition al or near vertical (> 45° angle) and at lease or GWS and to obtain static count rates a measurement locations. 02, "Evaluation and Documentation of the inal Status Surveys (FSS). The Scan MD enrichment. The actual RASS enrichment is calculated for FSS planning purposes.	
A minimum of one (1) discretionary of "sidewall": sidewall candidates for 12" in height. Instrumentation: Ludlum 2221 with 44-10 (2x2 NaI) collimation for investigations *Values based on information provi Scanning Minimum Detectable Cond for total Uranium reflects a conserv (2.0%) would result in Scan MDC va **IAL is the net count per minute (n	sidewall sample will be r sampling must be vertic detector; with Used for biased ded in HDP-TBD-FSS-0 centrations (MDC) for F ative assumption of 4% lues slightly less than tho ncpm) equivalent of an a	collected based on the following definition alor near vertical (> 45° angle) and at lead or GWS and to obtain static count rates in measurement locations. 02, "Evaluation and Documentation of the inal Status Surveys (FSS). The Scan MD enrichment. The actual RASS enrichment is calculated for FSS planning purposes. ctivity concentration less than the Uniform	
A minimum of one (1) discretionary of "sidewall": sidewall candidates for 12" in height. Instrumentation: Ludlum 2221 with 44-10 (2x2 NaI) collimation for investigations *Values based on information provi Scanning Minimum Detectable Cond for total Uranium reflects a conserv (2.0%) would result in Scan MDC va **IAL is the net count per minute (n Stratum DCGLw derived from the	sidewall sample will be r sampling must be vertic detector; with Used for biased ded in HDP-TBD-FSS-0 centrations (MDC) for F ative assumption of 4% lues slightly less than tho nepm) equivalent of an a technical bases presented	collected based on the following definition alor near vertical (> 45° angle) and at lead or GWS and to obtain static count rates measurement locations. 02, "Evaluation and Documentation of the inal Status Surveys (FSS). The Scan MD enrichment. The actual RASS enrichment is calculated for FSS planning purposes. ctivity concentration less than the Uniford in HEM-MEMO-15-021 and HDP-TBI	
A minimum of one (1) discretionary of "sidewall": sidewall candidates for 12" in height. Instrumentation: Ludlum 2221 with 44-10 (2x2 NaI) collimation for investigations *Values based on information provi Scanning Minimum Detectable Cond for total Uranium reflects a conserv (2.0%) would result in Scan MDC va **IAL is the net count per minute (n Stratum DCGLw derived from the	sidewall sample will be r sampling must be vertic detector; with Used for biased ded in HDP-TBD-FSS-0 centrations (MDC) for F ative assumption of 4% lues slightly less than tho nepm) equivalent of an a technical bases presented	collected based on the following definition al or near vertical (> 45° angle) and at lead or GWS and to obtain static count rates measurement locations. 02, "Evaluation and Documentation of the inal Status Surveys (FSS). The Scan MD enrichment. The actual RASS enrichment is calculated for FSS planning purposes.	

# 13.0 FINAL STATUS SURVEY IMPLEMENTATION LSA 12-04

FSS was performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.

# 13.1 Gamma Walkover Survey

# 13.1.1 Instrumentation

The selected instrumentation to perform the GWS in LSA 12-04 was a 2" x 2" NaI detector in combination with a Ludlum 2221 rate meter. Each NaI instrumentation set was interfaced with a Trimble DGPS and handheld data logger.

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Prior to the first field use of the GWS instrumentation, initial set-ups were performed. Also, daily pre- and post-use source checks were performed for each day that GWS was performed within the SU. Initial set-ups, daily source checks, and control charting were performed according to the requirements of HDP-PR-HP-416, *Operation of the Ludlum 2221 for Final Status Survey*.

#### **13.1.2 GWS Performance**

All GWS measurements on the excavation floor and sidewalls collected with the NaI detector(s) were connected to a Trimble DGPS and with a hand-held data logger. The logging frequency in the SU was one (1) GWS measurement per second. Each gross gamma measurement is correlated to a set of coordinates based on the Missouri East State Plane, NAD 1983.

The GWS requirements involved moving the NaI detector in a side-to-side fashion no faster than 1 foot per second while holding the probe as close as possible to the excavation surface (nominally 1", but not to exceed 3"). At the same time, the technician was required to slowly advance, causing the detector to trace out a serpentine path over the excavation surface.

FSS Technicians performing GWS in LSA 12-04 used the 4,000 ncpm IAL as a field guide to know when to slow or pause the GWS for more deliberate investigation. If during the GWS, audible count rates noticeably increase above the general area average (i.e., > minimum detectable count rate), FSS Technicians were required to pause momentarily and observe count rates. If sustained count rates approached the IAL, further focused investigation was conducted within the locally elevated area.

To use the IAL effectively, FSS Technicians first determined the local background count rate before starting the GWS. Although the ambient gamma level may vary across the SU due to excavation geometry and relative distance from contaminated materials in nearby remedial excavations, the average background rate (measured at waist level) within the LSA ranged between 10,000 and 11,000 gcpm. Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 14,000 to 15,000 gcpm, FSS Technicians slowed or paused the GWS for more careful investigation of the small areas of elevated activity before deciding if "flagging" a point for potential biased sampling was warranted.

Hard to reach areas, and non-typical areas were surveyed manually as necessary in order to assess the potential for an area of elevated residual activity over 100% of the exposed excavation surface.

After the GWS survey was complete, the GPS/GWS data was reviewed by Radiological Engineering and the Health Physics Technician performing the survey to determine if possible areas of elevated residual activity remained within the SU that required biased sample investigation. Areas that were flagged by the HP Technician were considered, as well as a statistical evaluation of the GWS data set. The statistical evaluation determined the mean count rate and standard deviation associated with the GWS and then could be used to identify any areas that exceeded 3 standard deviations above the mean. The number of biased samples to be collected and the locations are based on flagged locations exceeding the IAL, the statistical evaluation of the GWS data set, and the professional judgment of Radiological Engineering.

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#### 13.2 Soil Sampling

#### 13.2.1 Systematic Soil Sampling Summary

Table 13-1 provides a summary of systematic sampling by stratum for LSA 12-04.

	~,~~~~		~j~*******		
LSA	SU Area,	Systematic			
	planar (m <sup>2</sup> )	Surface	Root	Deep (Excavation)	QC
12-04	1,960	8	8	8*	2

# Table 13-1Systematic Sampling Summary by Stratum for LSA 12-04

\*Excavation samples were collected and archived, analysis only required if an overlying Root sample exceeds a 0.5 SOF

#### 13.2.2 Systematic Sampling LSA 12-04

Within LSA 12-04, there were 8 systematic locations in which the surface stratum (0 - 15 cm) was sampled in the SU. The underlying root stratum was sampled at all 8 locations. Excavation stratum samples were collected and archived, but were not required to be analyzed since no root stratum sample exceeded a 0.5 Uniform SOF.

Given a planar area of 1,960  $\text{m}^2$  for LSA 12-04 and an eight - point systematic triangular grid, the point-to-point distance within each row was 16.8 m with spacing of 14.5 m between each of the parallel grid rows within the SU.

While there were eight (8) systematic locations on the LSA 12-04 sampling grid, a total of eighteen (18) samples were collected and analyzed at these locations, including:

- Eight (8) samples collected and analyzed within the surface stratum
- Eight (8) samples collected and analyzed within the root stratum
- Zero (0) samples analyzed within the excavation, or "deep" stratum
- Two (2) QC field replicate

Figure 13-1 presents the map of the nine systematic sample locations which were sampled within LSA 12-04. The inset table notes the location coordinates (Missouri East, NAD 1983) and collection intervals for each systematic location.

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			LSA 12	Figure 13-1 2-04 Systematic Soil Sample Locations
Hematite	Veconwiss	ioning	↓ ↓ N Project	LSA 12-04 Systematic Sample Locations
Sample ID	Start End Depth Depth (inches) (inches	(teet)	Easting (feet)	LSA 12-04 1960 m <sup>2</sup> Planar Area L12-04-10-P-S-S-00 L12-04-13-P-S-S-00
L12-04-01-P-S-S L12-04-02-P-R-S L12-04-03-P-E-S	0 0 6 0 6 59 0 59 65	865539 865539 865539	827702 827702 827702	L12-04-11-P-R-S-00 L12-04-12-P-E-S-00 L12-04-15-P-E-S-00
L12-04-04-P-S-S L12-04-05-P-R-S L12-04-06-P-E-S L12-04-07-P-S-S L12-04-08-P-R-S	0         6         59           0         59         65           0         0         6           0         6         59	865492 865492 865492 865492 865492 865492	827674 827729 827729	L12-04-16-P-S-S-00 L12-04-17-P-R-S-00 L12-04-19-P-S-S-00 L12-04-20-P-R-S-00 L12-04-20-P-R-S-00 L12-04-21-P-E-S-00
L12-04-09-P-E-S L12-04-10-P-S-S L12-04-11-P-R-S L12-04-12-P-E-S L12-04-13-P-S-S	0 0 6 0 6 59 0 59 65 0 0 6	865492 865444 865444 865444 865444	827702 827702 827757	L12-04-21-P-E-3-00 L12-04-22-P-S-S-00
L12-04-14-P-R-S L12-04-15-P-E-S L12-04-16-P-S-S L12-04-17-P-R-S L12-04-17-P-R-S L12-04-18-P-E-S	0 59 65 0 0 6 0 6 59	865444 865444 865397 865397 865397	827785 827785	L12-04-23-P-R-S-00 L12-04-24-P-E-S-00
L12-04-19-P-S-S L12-04-20-P-R-S L12-04-21-P-E-S L12-04-22-P-S-S	0 0 6 0 6 59 0 59 65 0 0 6	865397 865397 865397 865349	827840 827840 827840 827812	N N
L12-04-23-P-R-S L12-04-24-P-E-S L12-04-02-P-R-C	0 59 65 0 6 59	865349 865349 865539	827812 827702	0 15 30 60 90 120 Feet
L12-04-16-P-S-C	0 0 6	865397	827785	

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Figure 13-2 below presents a tabular listing of all FSS samples collected within LSA 12-04 with associated IDs, sample types, collection intervals, coordinates, and notes.

Figure 13-2 FSS Sample Locations and Coordinates for LSA 12-04									
Hematite Decommissioning Project		Procedure:	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development						
						Revision: 10	Appendix P-4, Page 1 of 1		
				APPENDIX P-	4				
	F	SS SAMPL	E & MEASUR	EMENT LOCA	ATIONS & CO	DORDINATES			
Survey Area:	LSA	12		Description:		Laydown Are	a, Plant Soils SEA		
Survey Unit:	04	4	_	Description:	(	lass 1 Laydown	Land Area in "Area 13"		
			_			· · · ·			
Survey Type:	FS	S Classification: Class 1							
Measurement or Sample ID	Surface or CSM	Туре	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes		
L12-04-01-P-S-S-00	Uniform	S	433.0	432.5	865539	827702	Surface 6-inch grab		
L12-04-02-P-R-S-00	Uniform	S	432.5	428.1	865539	827702	Root 59-inch composite		
L12-04-04-P-S-S-00	Uniform	S	431.3	430.8	865492	827674	Surface 6-inch grab		
L12-04-05-P-R-S-00	Uniform	S	430.8	426.3	865492	827674	Root 59-inch composite		
L12-04-07-P-S-S-00	Uniform	S	431.7	431.2	865492	827729	Surface 6-inch grab		
L12-04-08-P-R-S-00	Uniform	S	431.2	426.8	865492	827729	Root 59-inch composite		
L12-04-10-P-S-S-00	Uniform	S	431.2	430.7	865444	827702	Surface 6-inch grab		
L12-04-11-P-R-S-00	Uniform	S	430.7	426.3	865444	827702	Root 59-inch composite		
L12-04-13-P-S-S-00	Uniform	S	430.8	430.3	865444	827757	Surface 6-inch grab		
L12-04-14-P-R-S-00	Uniform	S	430.3	425.9	865444	827757	Root 59-inch composite		
L12-04-16-P-S-S-00	Uniform	S	430.3	429.8	865397	827785	Surface 6-inch grab		
L12-04-17-P-R-S-00	Uniform	S	429.8	425.4	865397	827785	Root 59-inch composite		
L12-04-19-P-S-S-00	Uniform	S	431.4	430.9	865397	827840	Surface 6-inch grab		
L12-04-20-P-R-S-00	Uniform	S	430.9	426.5	865397	827840	Root 59-inch composite		
L12-04-22-P-S-S-00	Uniform	S	430.5	430.0	865349	827812	Surface 6-inch grab		
L12-04-23-P-R-S-00	Uniform	S	430.0	425.6	865349	827812	Root 59-inch composite		
L12-04-02-P-R-Q-00	Uniform	Q	432.5	428.1	865539	827702	Root 59-inch composite		
L12-04-16-P-S-Q-00	Uniform	Q	430.3	429.8	865397	827785	Surface 6-inch grab		
L12-04-10-P-S-Q-00	Uniform	B	430.3	429.8	865345.0	827819.0	Biased 6-inch grab		
	Smon	D	720.0	721.5	000040.0	02/01/.0	Brased 0-men grab		

Green shaded samples are the samples at each sample location, for use in WRS Test.

\*Elevations are in feet above mean sea level.

\*\* Missouri - East State Plane Coordinates [North American Datum (NAD) 1983]

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R

CSM: Three-Layer (Surface-Root-Excavation) or Uniform DCGLs used

Type: Systematic = S, Biased = B; QC =Q; Investigation = I

Quality Record

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## 13.3 Biased Soil Sampling

As discussed in FSSFR Volume 3, Chapter 1, Section 6.1.3, there are three key methods for identifying areas for biased soil sampling, the IAL, the Z-score of the FSS GWS, and the professional judgment of the HP Staff. For LSA 12-04 one (1) biased sample location was selected within the SU based on the evaluation of the GWS survey data and HP Technician professional judgment. This biased location represented the maximum GWS measurement encountered within the SU. Biased samples are collected at the prescribed location to a depth of 6 inches below the exposed ground surface.

# 13.4 Judgmental/Sidewall Sampling for Tc-99

As an un-excavated SU, no Tc-99 sidewall sampling was necessary for LSA 12-04.

# 13.5 Quality Control Soil Sampling

Two QC field duplicate sample point were randomly selected and collected at systematic location L12-04-02 and L12-04-16 for LSA 12-04.

### 14.0 FINAL STATUS SURVEY RESULTS LSA 12-04

### 14.1 Gamma Walkover Survey

Post-processed GPS coordinate data is accurate to within  $\pm 0.1$  m for the handheld GPS models used during the GWS. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same GPS location during the walkover, the most elevated radiological measurements are plotted "on top"(e.g. if any sidewalls featured more elevated readings than the floor directly below, the sidewall radiological measurements would overlie the lower floor readings).

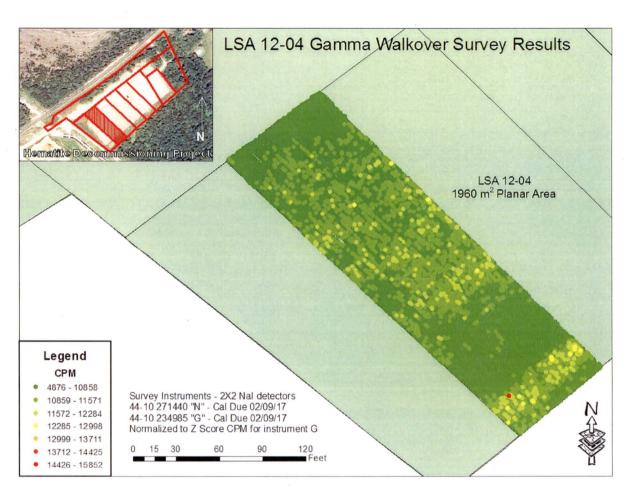
GWS measurements were collected in LSA 12-04 between May 6, 2016, and May 15, 2016.

### 14.1.1 GWS Results for LSA 12-04

For LSA 12-04, GWS count rates ranged between 4,876 gcpm and 15,852 gcpm, with a mean count rate of 10,144 gcpm. The median count rate was 10,364 gcpm with a standard deviation of 713 cpm. Figure 14-1 below presents a map of the complete GWS data set.

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Figure 14-1 Colorimetric GWS Plot for LSA 12-04

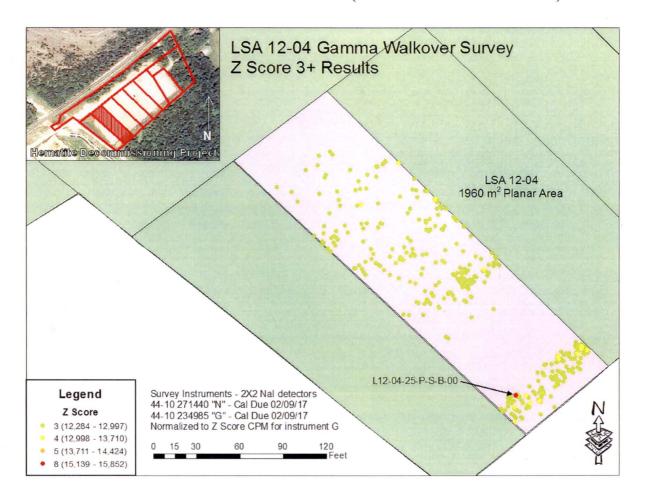


An evaluation of the entire GWS data set was performed to evaluate those small areas of elevated activity which exceeded both the IAL (> 4000 ncpm) and three (3) standard deviations above the GWS mean measurement, (i.e., "+3 Z-score"). One location (L12-04-25) was selected for biased sample collection. The sample collected at location L12-04-25 represented the maximum GWS measurement (15,852 gcpm) within the SU.

Figure 14-2 presents a map of the +3 Z-score GWS measurements within LSA 12-04, including the selected biased sampling location.

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Figure 14-2 Colorimetric GWS Plot for LSA 12-04 (Measurements > Z-score of 3)



All GWS data collected in LSA 12-04 was datalogged and post-processed in GIS software.

### 14.1.2 GWS Coverage Results LSA 12-04

FSSFR Volume 3, Chapter 1, Section 6.1.4, *Exposed Surfaces versus Accessible Surfaces*, provides a discussion and the criteria for evaluating the GWS coverage of a SU during FSS.

The post survey processing of the GPS data indicated that although 100% of accessible areas underwent GWS the GWS covered 99.79% of the SU (see Table 14-1). As the evaluation indicates that the GPS coverage exceeded 95% with no readings approaching or exceeding the IAL of 4,000 net cpm in the vicinity of any apparent GPS coverage gaps, the GWS coverage for the SU has been evaluated to meet the intent of the "100% GWS coverage" requirement.

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# Table 14-1GWS Gap Analysis LSA 10-04

	Total SU	GWS Gap	Gap	GWS	MARSSIM
	Pixels	Pixels	Percentage	Coverage	Class
LSA 12-04	152,548	321	0.21	99.79	1

## 14.2 Soil Sample Results LSA 12-04

Appendix B presents the analytical results and associated statistics for all FSS samples collected within LSA 12-04.

#### 14.2.1 Surface Soil Sample Results LSA 12-04

There were eight systematic samples collected within the surface stratum (0 - 15 cm) of LSA 12-04. Additionally there was one biased and one QC sample collected in the topmost layer of soil. The maximum Uniform SOF result for the surface samples was 0.20.

#### 14.2.2 Subsurface Soil Sample Results LSA 12-04

There were eight systematic locations within LSA 12-04 where root stratum composite sampling was necessary. The root stratum zone is between 0.15 and 1.50 m below final grade surface. At each of the eight root stratum composite sampling locations, the top six inches (1.50 - 1.65 m below final grade surface) of the underlying excavation stratum was also collected and archived, however these excavation samples were not required to be analyzed as no overlying root stratum sample exceeded a 0.5 SOF. The maximum SOF result of the subsurface samples collected in LSA 12-04 was 0.21.

#### 14.2.3 WRS Evaluation

Per Step 7.8.3 of HDP-PR-FSS-721 *Final Status Survey Data Evaluation*, the Wilcoxon Rank Sum (WRS) statistical test was not required for LSA 12-04 since the difference between the maximum SU data set gross SOF and the minimum background area SOF was less than one using the Uniform Stratum criteria. However, for illustrative purposes, the WRS evaluation was still performed for LSA 12-04. All systematically collected samples regardless of depth are used to perform the WRS Test, however biased and QC sample results are not utilized in the WRS Test. The 16 systematically collected samples in LSA 12-04 were ranked against the adjusted activity concentrations of the 32 samples collected within the Background Reference Area. The SU passed the WRS Test since the ranked sum of the reference area ranks, or test statistic  $W_{R}$ , (1040) was greater than the critical value (860) for the test. As such, the null hypothesis that the SU average concentration is greater than the DCGL<sub>W</sub> was rejected. The WRS evaluation is also included in Appendix B.

#### 14.2.4 Graphical Data Review LSA 12-04

Table 14-2 below presents summary results for the all systematically collected samples (includes surface, and root, but not biased or QC samples) collected within LSA 12-04, and the associated SOF when compared to the Uniform Stratum DCGL<sub>w</sub>s. The arithmetic average concentration resulted in a SOF of 0.09.

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#### **Table 14-2**

Statistic	Ra-226 DCGL = 1.9 BKG = 1.07 (pCi/g)	Tc-99 DCGL = 25.1 (pCi/g)	Th-232 DCGL = 2.0 BKG = 1.0 (pCi/g)	U-234 DCGL=195.4 (pCi/g)	U-235 DCGL=51:6 (pCi/g)	U-238 DCGL=168.8 (pCi/g)	Sample SOF (Uniform DCGL)
Average	0.033	0.185	0.091	1.968	0.062	1.212	0.09
Minimum	0.00 ( <bkg)< td=""><td>0.00 (NEG)</td><td>0.00 (<bkg)< td=""><td>0.545</td><td>-0.129</td><td>0.545</td><td>0.02</td></bkg)<></td></bkg)<>	0.00 (NEG)	0.00 ( <bkg)< td=""><td>0.545</td><td>-0.129</td><td>0.545</td><td>0.02</td></bkg)<>	0.545	-0.129	0.545	0.02
Maximum	0.250	0.716	0.290	6.545	0.360	1.790	0.21

Notes:

1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.

2. Average SOF for data set calculated using average radionuclide concentrations.

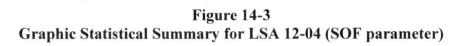
3. U-234 values are inferred from the U-235/U-238 ratio.

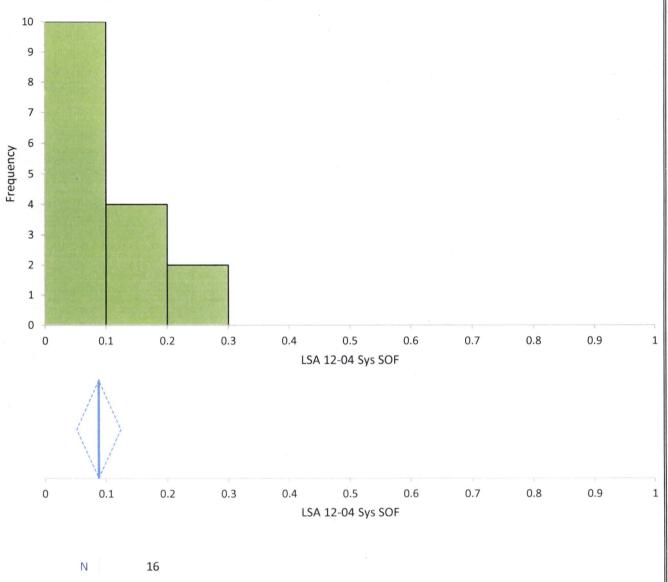
Section 8.2.2.2 of MARSSIM recommends a graphical review of FSS analytical data, to include at a minimum, a posting plot and a histogram. A frequency plot, or histogram, is a useful tool for examining the general shape of a data distribution. This plot is a bar chart of the number of data points within a certain range of values. The frequency plot will reveal any obvious departures from symmetry, such as skewness or bimodality (two peaks), in the data distribution for the survey unit. The presence of two peaks in the survey unit frequency plot may indicate the existence of isolated areas of residual radioactivity.

Figure 14-3 presents the overall statistical metrics for the SOF parameter for the 16 systematically collected samples from LSA 12-04. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 12-04. The middle graph presents the mean SOF (0.09) as indicated by the blue vertical line of the sample population and the 95% confidence interval of the mean SOF represented by the blue diamond which is 0.05to 0.12. The 97.87% confidence interval based on the median (0.08) of the sample results is 0.02 to 0.15. The bottom two charts present the various statistical metrics of the LSA 12-04 SOF data set, including the mean, median, standard deviation, minimum, maximum, confidence intervals, etc.

Figure 14-3 exhibits no unusual symmetry or bimodality concerns for the LSA 12-04 data associated with the systematically collected measurement locations.

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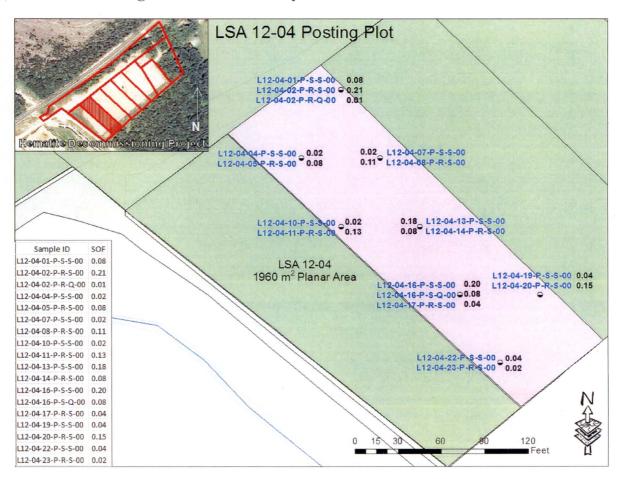


	Mean	95%	% CI	Mean SE	SD	Variance	Skewness	Kurtosis
LSA 12-04 Sys SOF	0.09	0.05	to 0.12	0.017	0.07	0.00	0.6	-1.02
001								
		1st				3rd		
	Minimum	quartile	Median	97.87	7% CI	quartile	Maximum	IQR
LSA 12-04 Sys SOF	0.02	0.03	0.08	0.02	to 0.15	0.14	0.2	0.11

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A posting plot is simply a map of the SU with the data values (in this case the SOF values for each systematically collected sample) entered at the measurement locations. This potentially reveals heterogeneities in the data – especially possible patches of elevated residual radioactivity. The posting plot for LSA 12-04 is presented below in Figure 14-4. Figure 14-4 shows no unusual patterns in the data.

Figure 14-4 Posting Plot for LSA 12-04 Systematic Measurement Locations



Appendix B to this report presents the complete analytical data set (in Microsoft Excel format) used to derive the summary statistics presented in Table 14-2, Figure 14-3, and Figure 14-4 above. A summary of the analytical data is presented in Table 14-3 below. Appendix P to this report presents the Test America Analytical Laboratory soil sample reports.

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Table 14-3

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#### Final Status Survey Analytical Data: LSA 12-04 DC) **TestAmerica Analytical Results** Sample Depth (ft) Sample ID Ra-226 Tc-99 Th-232 Inferred U-234 U-235 , m d o **Corrected Result Corrected Result** Uncertainty Uncertainty Uncertainty Corrected Res Uncertainty Net Result\* Net Result\* Uncertainty Qualifier Qualifier Qualifier Qualifier Result Result Result Result Result (Syste MDC MDC MDC MDC 1.16 0.178 0.0868 N/A 0.090 0.090 0.323 0.323 0.127 0.226 N/A 0.949 0.196 0.121 N/A -0.051 0.000 2.091 NA NA NA 0.112 0.223 L12-04-01-P-S-S-00 0.00 0.0512 1.18 0.153 N/A 0.110 0.110 -0.0217 0.000 0.037 0.241 U 1.26 0.2 0.0975 N/A 0.260 0.260 2.045 NA NA NA 0.11 0.138 L12-04-02-P-R-S-00 0.50 S S 0.965 0.146 0.0649 N/A -0.105 0.000 0.061 0.061 0.016 0.226 U 1.01 0.17 0.0977 N/A 0.010 0.010 0.979 NA NA NA -0.008 0.197 L12-04-04-P-S-S-00 0.00 0.0598 N/A 0.247 N/A 1.03 0.030 NA NA 0.36 0.158 0.97 0.137 -0.100 0.000 0.276 0.276 0.058 0.152 0.0785 N/A 0.030 6.545 NA L12-04-05-P-R-S-00 0.50 S 1.02 0.139 0.0676 N/A -0.050 0.000 0.0677 0.068 0.058 0.233 U 0.99 0.153 0.111 N/A -0.010 0.000 1.343 NA NA NA 0.0653 0.16 L12-04-07-P-S-S-00 0.00 S 0.234 0.221 0.984 0.141 0.0674 N/A -0.086 0.000 0.716 0.716 0.102 N/A 1.16 0.194 0.0949 N/A 0.160 0.160 0.545 NA NA NA -0.097 L12-04-08-P-R-S-00 0.50 S 0.999 0.15 0.0637 N/A -0.071 0.000 0.0167 0.017 0.016 0.238 U 0.961 0.174 0.106 N/A -0.039 0.000 2.097 NA NA NA 0.107 0.209 0.00 S L12-04-10-P-S-S-00 0.154 0.0765 N/A -0.030 0.000 0.0976 0.098 0.125 0.244 U 1.22 0.19 0.126 N/A 0.220 0.220 1.520 NA NA -0.129 0.191 S 1.04 NA L12-04-11-P-R-S-00 0.50 0.0954 0.250 0.234 1.05 0.157 2.409 S 1.32 0.203 N/A 0.250 0.166 0.166 0.058 U 0.178 N/A 0.050 0.050 NA NA NA 0.13 0.122 L12-04-13-P-S-S-00 0.00 0.232 S 0.996 0.131 0.0566 N/A -0.074 0.000 0.0116 0.012 0.014 U 1.11 0.158 0.0891 N/A 0.110 0.110 2.184 NA NA NA 0.11 0.207 L12-04-14-P-R-S-00 0.50 1.14 0.157 0.0568 N/A 0.070 0.070 -0.0023 0.000 0.109 0.228 U 1.29 0.221 0.103 N/A 0.290 2.136 NA NA NA 0.112 0.199 0.290 L12-04-16-P-S-S-00 0.00 S 0.972 0.131 0.0648 N/A -0.098 0.000 0.0996 0.100 0.057 0.226 U 1.04 0.159 0.117 N/A 0.040 0.040 1.350 NA NA NA -0.02 0.0402 L12-04-17-P-R-S-00 0.50 S N/A 0.228 N/A 0.186 1.04 0.162 0.0812 -0.030 0.000 0.395 0.395 0.174 0.984 0.187 0.119 N/A -0.016 2.155 NA NA NA 0.113 L12-04-19-P-S-S-00 0.00 S 0.000 1.06 0.0725 N/A -0.010 0.0228 0.023 0.074 0.228 0.223 NA NA -0.122 0.197 0.163 0.000 U 1.28 0.12 N/A 0.280 0.280 1.280 NA L12-04-20-P-R-S-00 0.50 S 0.0717 N/A -0.261 0.595 0.237 0.317 N/A 0.925 0.0881 NA 0.0673 0.161 L12-04-22-P-S-S-00 S 0.809 0.13 0.000 0.595 0.155 N/A -0.075 0.000 1.293 NA NA 0.00 0.891 0.14 0.0673 N/A -0.179 0.118 0.019 0.236 0.993 0.118 1.515 NA NA 0.0781 0.22 0.000 0.118 U 0.167 N/A -0.007 0.000 NA L12-04-23-P-R-S-00 0.50 S 0.242 0.2 0.861 0.134 0.0788 N/A -0.209 0.000 0.0725 0.073 0.058 U 0.937 0.172 0.122 N/A -0.063 0.000 1.190 NA NA NA -0.134 L12-04-02-P-R-Q-00 0.50 Q 1.14 0.166 0.0803 N/A 0.070 0.070 0.0072 0.007 0.011 0.239 U 1.08 0.171 0.111 N/A 0.080 0.080 0.702 NA NA NA 0.0387 0.0599 L12-04-16-P-S-Q-00 Q 0.00 0.869 0.142 0.076 N/A -0.201 0.000 0.287 0.287 0.139 0.234 N/A 0.848 0.149 0.113 N/A -0.152 0.000 1.855 NA NA NA 0.097 0.097 L12-04-25-P-S-B-00 0.00 в Systematic Minimum 0.000 0.000 0.000 0.545 -0.129 Systematic Maximum 0.250 0.716 0.290 6.545 0.360 Systematic Mean 0.033 0.185 0.062 0.091 1.968 Systematic Median 0.000 0.099 0.035 0.093 1.783 Systematic Standard Deviation 0.069 0.220 0.113 1.327 0.120 With ingrowth, use Ra226 bkg = 1.07 Th232 bkg = 1.0

NOTES:

Gross results in units of pCi/g.

\* Background with ingrowth (1.07 pCi/g) subtracted from gross result.

\*\*Background (1.0 pCi/g) subtracted from gross result.

U Qualifier: Result is less than the sample detection limit

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13							
			U-2	38		Enr.	SOF
MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Enrichment (%)	SOF
0.377	U	0.973	0.317	0.853	N/A	1.8	0.08
0.19	U	0.9	0.484	0.756	N/A	1.9	0.21
0.591	U	0.979	0.334	0.873	N/A	0.7	0.02
0.18	N/A	1.79	0.51	0.706	N/A	3.1	0.08
0.511	U	1.37	0.533	0.795	N/A	0.8	0.02
0.409	U	0.545	0.242	1.21	U	0.7	0.11
0.581	U	1.57	0.735	0.893	N/A	1.1	0.02
0.561	U	1.52	0.551	0.815	N/A	0.7	0.13
0.198	U	1.03	0.373	1	N/A	2.0	0.18
0.471	U	1.7	0.682	0.78	N/A	1.0	0.08
0.369	U	1.26	0.504	0.751	N/A	1.4	0.20
0.518	U	1.35	0.743	0.862	N/A	0.7	0.04
0.211	U	1.28	0.585	0.886	N/A	1.4	0.04
0.628	U	1.28	0.571	0.864	N/A	0.7	0.15
0.529	U	0.832	0.299	0.763	N/A	1.3	0.04
0.367	U	1.01	0.522	0.804	N/A	1.2	0.02
0.642	U	1.19	0.561	0.855	N/A	0.7	0.01
0.547	U	0.164	0.775	1.29	U	3.6	0.08
0.608	U	1.200	0.574	0.878	N/A	1.3	0.03
			0.54	45		1.4	0.02
			1.79	90		(%)	0.21
			1.21	12		Average Enrichment (%)	0.09
			1.27	70		Avelichn	0.08
			0.33	39		Enri	0.07
	-						

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### 14.2.5 Biased Soil Sample Result LSA 12-04

One (1) biased sample was collected from LSA 12-04. The sample collected at location L12-04-25 represented the maximum GWS measurement (15,852 gcpm) within the SU, and had a result of 0.03 Uniform SOF.

# 14.2.6 Quality Control Soil Sample Result LSA 12-04

Two QC field duplicate sample points were randomly selected for LSA 12-04 which were collected at systematic locations L12-04-02 and L12-032-16.

For the 17 samples (i.e., 16 systematic + 1 biased) collected within LSA 12-04, two field duplicate samples were collected. This frequency equates to 11.8%, (i.e. 2/17). Form HDP-PR-FSS-703-1 documents that the duplicate sample result comparison with the partner's sample results that all comparison criteria were less than the calculated warning limits (see Figure 14-5 below).

The statistical assessment of the Laboratory QC sample results indicated that one field duplicate sample exceeded the calculated Warning Limit, but was less than the calculated Control Limit. The one sample result that exceeded the Warning Limit was sample L12-04-02-P-R-S-00 for Ra-226 and Th-232. In accordance with procedure HDP-PR-FSS-703, when an exceedance occurs an investigation is performed to determine if corrective actions were necessary. The investigation determined that for Ra-226 the calculated statistic (0.319) only slightly exceeded the calculated Warning Limit (0.269), and for Th-232, the calculated statistic (0.323) only slightly exceeded the calculated Warning Limit (0.283). Also, considering the low activity and the errors associated with the sample results, the Ra-226 and Th-232 activity of both samples were relatively close. Based upon the investigation of the exceedance and the results of previous Quality Assurance audits of the overall performance of the laboratory, no corrective actions were determined to be necessary.

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	Form I	IDP-PR-FS	SS-703-1 ]	Field D	Figure 14 Suplicate Sa		ssessment L	SA 12-04	4 (1 of 2)	)		
Hematite Decommissioning	Procedure: HDP-PR	-FSS-703, Fin	al Status Sur	vey Qua	llity Control		·······					
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<u> </u>	<u></u>	<u> </u>	<u></u>	F	ORM HDP-I	PR-FSS-7	03-1	<u> </u>	<u> </u>			
			FIE	LD DU	PLICATE SA	AMPLE A	SSESSMENT					
Survey Unit No.:	LSA 12-04				Survey Unit D	escription:	Class 1 Laydov	I and Are	o in "Area	3"		
Survey Onit No.:	LSA 12-04	<u> </u>			Field Duplica	ite Sample	Average	Nuclide				Statistic
Sample ID	Field Duplicate Sample ID	· · · ·	Sample (p	-	(pCi/ Activity (x <sub>i</sub> )	g) MDC	Activity $(\bar{\chi})$ (pCi/g)	DCGL (pCi/g)	Statistic <sup>2</sup>	Warning Limit	Control Limit	Exceeds Limit? (Y/N)
_12-04-02-P-R-S-00	L12-04-02-P-R-Q-00	Ra-226	1.18	0.0512	0.861	0.0788	1.021	1.9	0.319	0.269	0.403	Y
-12-04-02-P-R-S-00	L12-04-02-P-R-Q-00	Tc-99	-0.0217	0.241	0.0725	0.242	0.025	25.1	NA	3.552	5.321	NA
_12-04-02-P-R-S-00	L12-04-02-P-R-Q-00	Th-232	1.26	0.0975	0.937	0.122	1.099	· 2.0	0.323	0.283	0.424	Y
_12-04-02-P-R-S-00	L12-04-02-P-R-Q-00	U-234 <sup>1</sup>	2.045	N/A	1.190	N/A	1.618	195.4	0.855	27.649	41.425	N
_12-04-02-P-R-S-00	L12-04-02-P-R-Q-00	U-235	0.112	0.19	-0.134	0.642	-0.011	51.6	NA	7.301	10.939	NA
_12-04-02-P-R-S-00	L12-04-02-P-R-Q-00	U-238	0.9	0.756	1.19	0.855	1.045	168.8	0.290	23.885	35.786	N
	o MDC available. It is not necessary if the $\frac{1}{2} + \frac{1}{2} +$			MDC.			Reviewed by:	W.Cla	nteres	JW.(	he	1
	1-23-16							23 / 14	/			

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	Form H	DP-PR-FS	S-703-1 H	Field D	Figure 14 Puplicate S		ssessment	LSA 12-	04 (2 of	2)		
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· ·			FIE		FORM HDP- PLICATE SA		03-1 SSESSMENT			<u>L</u>		
Survey Unit No.:	LSA 12-04				Survey Unit I	Description:	Class I Laydov	n Land Are	a in "Area	13"		
	Field Duplicate		Sample (p		Field Duplica (pCi/	/g)	Average Activity $(\bar{\chi})$	Nuclide DCGL		Warning	1	Statistic Exceeds Limit?
Sample ID	Sample ID	Radionuclide			Activity (x <sub>i</sub> )	MDC.	(pCi/g)	(pCi/g)	Statistic <sup>2</sup>	Limit	Limit	(Y/N)
L12-04-16-P-S-S-00	L12-04-16-P-S-Q-00	Ra-226 Tc-99	1.14 -0.00228	0.0568	1.14 0.00717	0.0803	1.140	1.9	0	0.269	0.403	N NA
L12-04-16-P-S-S-00 L12-04-16-P-S-S-00	L12-04-16-P-S-Q-00 L12-04-16-P-S-Q-00	Th-232	1.29	0.228	1.08	0.239	0.002	25.1	NA 0.210	3.552 0.283	5.321	NA N
L12-04-16-P-S-S-00	L12-04-16-P-S-Q-00	U-234 <sup>1</sup>	2.136	N/A	0.702	N/A	1.419	195.4	1.434	27.649	41.425	N
L12-04-16-P-S-S-00	L12-04-16-P-S-Q-00	U-235	0.112	0.369	0.0387	0.547	0.075	51.6	NA	7.301	10.939	NA
L12-04-16-P-S-S-00	L12-04-16-P-S-Q-00	U-238	1.26	0.751	0.164	1.29	0.712	168.8	NA	23.885	35.786	NA
Comments: 1. U-234 is inferred, r 2. Duplicate assessme	no MDC available. ent is not necessary if the	result of either	sample is < 1	MDC.								
Performed by: 7	homes Yardy	In la	<u> </u>				Reviewed by:	W.C	Hark E	vas/	W C	ha
Date: /1	- 2 3 -/ <del>[.</del>					·	Date: 11/23	116				
Quality Record	· .											

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# 14.3 Tc-99 Hot Spot Assessment LSA 12-04

There is no historical sampling data available for this area since it was always considered a nonimpacted area prior to the storage of potential reuse soils within the LSA. As a previously unimpacted area there is no history of a Tc-99 sample result ever exceeding the Tc-99 Uniform  $DCGL_w$ , as only potential reuse soil was placed within the LSA. The highest Tc-99 sample result collected from both Final RASS and FSS was 2.42 pCi/g. Therefore there is no concern for a potential Tc-99 hot spot exceeding the  $DCGL_w$  of 25.1, and there is no reason to perform a Tc-99 hot spot assessment.

# 15.0 ALARA EVALUATION LSA 12-04

All samples collected within LSA 12-04 were evaluated against the Uniform Stratum DCGL<sub>w</sub>. For LSA 12-04 no sample result exceeded a SOF of 1.0. The average SOF result, based on all systematically collected samples, was 0.09 for LSA 12-04. The average SOF equates to residual activity contributions from the survey unit area of 2.25 mrem/yr for LSA 12-04. Groundwater Monitoring Well data provided in FSSFR Volume 6, Chapters 2 and 3 {ML16287A528}, and Chapter 4 {ML16342B552}, indicate that the groundwater dose contribution will be a fraction of the MCLs. Nevertheless, a maximum groundwater contribution assumption of 4.0 mrem/yr based upon the EPA MCLs will be added to the total estimated dose for LSA 12-04. Adding these dose contributions together, the total estimated dose for LSA 12-04 is 6.25 mrem/yr.

Since the estimated Total Effective Dose Equivalent is well below the regulatory release criterion of 25 mrem/yr, the conclusion of the ALARA evaluation is that the FSS of LSA 12-04 was successful and that there would be no discernable benefit to the health and safety of the public in attempting to further reduce the results of FSS by performing remediation of LSA 12-04.

# 16.0 FSS PLAN DEVIATIONS LSA 12-04

# 16.1 Remedial Actions during FSS

There were no remedial actions after FSS in LSA 12-04.

# 16.2 Adjustments to Scan MDC Calculations

Scan MDCs for LSA 12-04 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD- FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. The assumed LSA background count rate of 10,000 cpm was applied to determine the prospective Scan MDCs, and the actual mean count rate from the FSS survey was 10,144 cpm. Therefore the calculated Scan MDCs are appropriate, and no adjustments need to be made.

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# 17.0 DATA QUALITY ASSESSMENT

The DQO process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process are presented in Volume 3, Chapter 1, Section 4.0 of the FSSFR and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

# 17.1 Data Quality Assessment for LSA 12-04

The Data Quality Assessment of the survey methodology, sampling and sample analysis results, and the Quality Control sampling and analysis results to ascertain the validity of the conclusion for LSA 12-04 (see Figure 17-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-416 (*Operation of the Ludlum 2221 for Final Status Survey*).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.
- The systematic samples that were collected (on a random-start triangular grid) and the gamma scan surveys that were conducted were performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.
- All samples sent for analysis at the approved offsite laboratory (TestAmerica) were tracked on a chain of custody form in accordance with HDP-PR-QA-006, *Chain of Custody*.
- Quality Control sample results were verified to meet the acceptance criteria as specified in HDP-PR-FSS-703, *Final Status Survey Quality Control*.
- LSA 12-04 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.
- The WRS Test is not necessary when the difference between the maximum survey unit data set measurement SOF and the minimum background area measurement SOF is less than or equal to one. For LSA 12-04, no individual gross SOF result in the FSS data set exceeded the SOF of the minimum background reference area measurement by more than one using the Uniform Stratum criteria. Therefore, the WRS Test was not required for LSA 12-04. However the WRS Test was still performed for illustrative purposes. Since the test statistic, WR (1040) exceeded the critical value (860), the FSS data set passed the WRS Test and the null hypothesis was rejected. The WRS Test worksheet is presented in Appendix B.
- A biased soil sample was collected from the location of the highest gamma count rate within the SU, with a maximum result of 0.03 Uniform SOF.

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	The maximum SOF result for all surface samples wi The maximum SOF result for all subsurface samples w The average SOF result for all systematically collected was 0.09, with an upper 95% confidence level (UCL <sub>mea</sub>	vithin LSA 12-04 was 0.21. samples within LSA 12-04
	No FSS sample result in LSA 12-04 exceeded a SOF Uniform Stratum criteria, therefore an EMC or supple not required. For the same reason, no comparisons to t multi-CSM (i.e. Surface, Root and Excavation) DCGLs	emental investigations was the alternate "Three-Layer"
-	A retrospective sampling frequency evaluation was sufficient statistical power exists to reject the null hyp number of systematic samples actually collected we successful result of the retrospective power evaluation LSA 12-04 indicates that the minimum number of sa WRS Test was equal to the number of sampling low within LSA 12-04. The methodology used for the frequency evaluation is similar to the prospective sperformed during FSS Plan Development except that and statistics are used in the sample size verification. standard deviation of the eight LSA surface samples ( data set) are used to derive the relative shift for each LS and Type II errors of 0.05 and 0.10, respectively, the then correlated to a minimum sample size number as MARSSIM.	pothesis based on the total within LSA 12-04. The presented in Table 17-1 for amples required (8) for the ocations actually collected he retrospective sampling sample size determination actual FSS sample results Specifically, the mean and (i.e., the WRS Test sample SA. Given the HDP Type I calculated relative shift is
	HDP staff ensured that a visual inspection of the SU Isolation & Control measures were performed period there were no instances of potential cross contamination the FSS of all remaining areas at HDP were completed.	lically, and confirmed that n from weather events until

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# Table 17-1Retrospective Sample Size Verification for LSA 12-04

Uniform DCGL Criteria Evaluation					
N/2 Value Verification					
Isotope(s)	SOF (Ra/Tc/Th/Iso U)				
St. Dev.	0.07				
DCGL <sub>SOF</sub>	1				
LBGR (Mean)	0.09				
Shift	0.91				
Relative Shift (Δ/σ)	13.42				
MARSSIM Table 5.1 (Pr)	1.000000				
Ν	12				
N + 20%	14.4				
N/2	8				
FSS N/2	8				
Verification Check	SUFFICIENT MEASUREMENTS				

"N/2" Corresponds to the number of survey unit measurement locations required for the WRS Test

MARSSIM Table 5.1					
Δ/σ	Pr				
0.1	0.528182				
0.2	0.556223				
0.3	0.583985				
0.4	0.611335				
0.5	0.638143				
0.6	0.664290				
0.7	0.689665				
0.8	0.714167				
0.9	0.737710				
1.0	0.760217				
1.1	0.781627				
1.2	0.801892				
1.3	0.820978				
1.4	0.838864				
1.5	0.855541				
1.6	0.871014				
1.7	0.885299				
1.8	0.898420				
1.9	0.910413				
2.0	0.921319				
2.25	0.944167				
2.5	0.961428				
2.75	0.974067				
3.0	0.983039				
3.5	0.993329				
4.0	0.997658				
4.01	1.000000				

#### MARSSIM Table 5.2, $\alpha = 0.05$ , $\beta = 0.10$

α (or β)	$Z_{1-\alpha}$ (or $Z_{1-\beta}$ )
0.005	2.576
0.01	2.326
0.015	2.241
0.025	1.960
0.05	1.645
0.10	1.282
0.15	1.036
0.2	0.842
0.25	0.674
0.30	0.524

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	Figure 17-1 Data Evaluation Checklists prepared for LSA 12	2-04 (page 1 of	[2]
Llowetit	Procedure: HDP-PR-FSS-721, Final Status Survey Data E	Evaluation	
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F	APPENDIX G-1 INAL STATUS SURVEY DATA QUALITY OBJECTIVES R	REVIEW CHECK	LIST
Survey A Survey I			Area 13"
to d	e all measurements and/or analysis results that will be subjected ata analysis for FSS been individually reviewed and validated in ordance with Section 8.1 of this procedure?		
acqu	ve all systematic measurements and/or samples been taken or uired at the locations specified in the FSSP and the FSS Sample ructions?		
	ve all scans surveys been performed of the areas specified as aired in the FSSP and the FSS Sample Instructions?	s Yes 🛛 No	· 🗆 🔰
	ve all biased measurements and/or samples been taken or acquired the locations specified in the FSSP & the FSS Sample Instructions?		<b>NA</b> .
	ve duplicate and/or split samples or measurements been taken or uired at each location designated as a QC sample?	r Yes 🛛 No	
capa	re the instruments used to measure or analyze the survey data able of detecting the ROCs or gross activity at a MDC less than appropriate investigation level?		
ana	s the calibration of all instruments that were used to measure or lyze data, current at the time of use and were those calibrations formed using a NIST traceable source?		
	re the instruments successfully response-checked before use and ere required, after use on the day the data was measured?	'Yes 🛛 No	
1	the samples match those identified on the chain of custody?	Yes 🛛 No	
	the QC Sample Results meet the acceptance criteria as specified ir P-PR-FSS-703, Final Status Survey Quality Control?	<sup>n</sup> Yes⊠* No	
11. Are	all Laboratory QC parameters within acceptable limits?	Yes 🛛 No	
	was the response to any of the questions above, then document e actions that were taken to resolve the discrepancy.	at the discrepancy	as well as any
	nts: *One QC duplicate sample L12-04-02-P-R-Q-00 exceeded W 232, but did not exceed Control Limit, results acceptable.	arning Limit for R	a-226

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	) Data Evaluatio	Figur Figur	e 17-1 pared for LSA 1	2-04 (page 2)	of 2)
Hematite		P-PR-FSS-721, Final S			
Decommissionir Project	ıg	<u> </u>		Revision: 10	Appendix G-1, Page 2 of 2
FINA	L STATUS SURV	APPEND VEY DATA QUALIT		EVIEW CHECK	
Survey Area Survey Unit	::LSA 12	Descript	on: Laydown Area	, Plant Soils SEA	
Discrepancy	N/A				
		·····		·	
Corrective A	ctions Taken: <u>N</u> /	<u>'A</u>		<u></u>	
			<u>.                                    </u>		
		· · ·	·····	·	
		<u> </u>			
	· · · · · ·		· · · · · · · · · · · · · · · · ·		
		is resolved the discrepan	ncy with the data?	Yes 🗌 No	D 🗌 NA 🖂
		his form to the RSO. vill be answered by the	RSO		
a. If the		on 1/1 was "No", then is		Yes 🗍 No	□ 🗌 NA 🔀
b. If "N	lo", then are the ex	isting valid measureme te compliance for the su		Yes 🗍 No	
		acquisition of addition e for the survey unit.	al measurements or s	amples as necessa	ary to
Prepared	by (HP Staff):	Thomas Yardy	in the	hature)	1 - 2 3 - 1 <u>(Date)</u>
Tropurcu			(3)	P	1/22/1/2

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# 18.0 CONCLUSION LSA 12-04

An adequate quantity and quality of radiological surveys and samples, as well as the corresponding laboratory analysis has been performed, evaluated and documented to demonstrate that the dose associated with all sources within SU LSA 12-04 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402.

# Table 18-1LSA 12-04 SOF and Dose Summation

	AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	BURIED PIPING	REUSE SOIL	TOTAL
SOF	0.09	N/A	0.16	N/A	N/A	0.25
DOSE	2.25 mrem/year	N/A	4.0 mrem/year	N/A	N/A	6.25 mrem/year

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#### 19.0 FINAL STATUS SURVEY DESIGN LSA 12-05

This section of the report describes the method for determining the number of samples required for the FSS of LSA 12-05 as well as summarizing the applicable requirements of the FSS Plan. These include the DCGL<sub>W</sub>, scan survey coverage, and IAL. The radiological instrumentation used in the FSS of LSA 12-05 and the detection sensitivities are also discussed.

#### **19.1** FSS Plan Design Requirements

FSS Plan requirements for LSA 12-05 were driven by the type (Open Land) and Class (Class 1) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development*, November 2015.

#### **19.1.1 Surrogate Evaluation Areas**

A discussion of Surrogate Evaluation Areas is given in the FSSFR Volume 3, Chapter 1, Section 5.0, *Final Status Survey Design*.

#### 19.1.2 DCGL<sub>w</sub>

During the FSS design process a review was performed of the RASS data for LSA 12-05. The RASS data was used as confirmation that no known areas of residual radioactivity remained within the survey areas that exceeded the Uniform Stratum DCGL<sub>w</sub>. Therefore the Uniform Stratum DCGL<sub>w</sub> was selected for use in demonstrating compliance with the release criteria.

#### 19.1.3 GWS Coverage

As a Class 1 SU, LSA 12-05 was required to undergo a 100% GWS.

#### **19.1.4 Instrumentation**

Radiological instrumentation selected for performance of GWS within LSA 12-05 was the Ludlum 44-10 2" x 2" NaI detectors, coupled to a Ludlum 2221 scaler-ratemeter.

#### 19.1.5 Scan Minimum Detectable Concentration

Scan MDCs for LSA 12-05 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD- FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. As background levels were approximately 10,000 cpm within LSA 12-05, the scan MDC calculation for total uranium given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.2.6.d, was applied:

Scan MDC (total uranium) = 
$$\frac{1}{\left(\left(\frac{f_{U}-234}{3659 \ pCi/g}\right) + \left(\frac{f_{U}-235}{2.32 \ pCi/g}\right) + \left(\frac{f_{U}-238}{30.6 \ pCi/g}\right)\right)}$$

Equation 19-1

To determine isotopic Uranium fractions HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* assumes that the average LSA enrichment is 4% or less. Based on the

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systematically collected RASS samples in LSA 12-05, the average enrichment for the SU was 2.96%. All other Scan MDC parameters agreed upon between Westinghouse and the NRC were applied (e.g. use of a 2 in air gap, scan rate of 1 ft/sec, 0.75 surveyor efficiency), therefore no subsequent changes to the calculated Scan MDCs need to be made.

Prospectively calculated Scan MDCs for 2" x 2" NaI detectors that were used in LSA 12-05 are shown below:

# Table 19-1Scan MDCs for 2" x 2" NaI detector, 10,000 cpm background: LSA 12-05

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 12-05	40.9	46.6	1.21	2.8	0.87	3.0

\*DCGL<sub>w</sub> includes background concentrations of 0.9 pCi/g for Ra-226 (no ingrowth) and 1.0 pCi/g for Th-232. DCGLw values are based on the Uniform Stratum release criteria.

The values in Table 19-1 reflect those presented in the FSS Plans prepared for the SU prior to FSS.

#### **19.1.6 Investigation Action Level**

FSSFR Volume 3, Chapter 1, Section 6.1.3, *Investigation Action Level (IAL)*, provides a discussion in regards to the IAL. The basis of the IAL is detailed in HDP memorandum, HEM-15-MEMO-021 "Evaluation of the Scan IAL for Class 1 areas at the Westinghouse Hematite Site". The IAL used during the GWS of LSA 12-05 was established at 4,000 ncpm.

#### 19.1.7 LSA 12-05 FSS Design Summary

The FSS Plans for LSA 12-05 can be found in Appendix J. Table 19-2 presents an overall FSS design and implementation summary for LSA 12-05.

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<b>Table 19-2</b>	
FSS Design Summary for LSA 12-05	

Scan Coverage		100% exposed soil and rock	
		40.9 pCi/g total Uranium (based on a 10,000	
Scan MDC	•	cpm background); 0.87 pCi/g Th-232; 1.21	
		i/g Ra-226*	
Investigation Action Level (IAL)	4,0	00 net cpm **	
Systematic Sampling Locations:			
Depth	Number of Sample	Comments	
0 - 15 cm (Surface)	8	These complex will be taken on a	
15 cm – 1.5 m (Root)	8	<ul> <li>These samples will be taken on a</li> <li>random-start systematic grid.</li> </ul>	
> 1.5m (Excavation)	8	random-start systematic grid.	
<b>Biased Survey/Sampling Locations</b>	S:	· · · · · · · · · · · · · · · · · · ·	
Sidewall Sampling Locations: A minimum of one (1) discretionary	sidewall sample will be	Radiological Engineering.	
A minimum of one (1) discretionary	•	collected based on the following definition	
A minimum of one (1) discretionary of "sidewall": sidewall candidates f	•	collected based on the following definition	
A minimum of one (1) discretionary of "sidewall": sidewall candidates f least 12" in height. Instrumentation:	for sampling must be ve	collected based on the following definition rtical or near vertical (> 45° angle) and a or GWS and to obtain static count rates a	
A minimum of one (1) discretionary of "sidewall": sidewall candidates f least 12" in height. Instrumentation:	or sampling must be ve detector; with Used f	collected based on the following definitio rtical or near vertical (> 45° angle) and a	
A minimum of one (1) discretionary of "sidewall": sidewall candidates f least 12" in height. Instrumentation: Ludlum 2221 with 44-10 (2x2 NaI) collimation for investigations	detector; with Used f	collected based on the following definition rtical or near vertical (> 45° angle) and a or GWS and to obtain static count rates a measurement locations.	
A minimum of one (1) discretionary of "sidewall": sidewall candidates for least 12" in height. Instrumentation: Ludlum 2221 with 44-10 (2x2 NaI) collimation for investigations *Values based on information provi	or sampling must be ve detector; with Used f biased ded in HDP-TBD-FSS-	collected based on the following definition rtical or near vertical (> 45° angle) and a or GWS and to obtain static count rates a measurement locations. 002, "Evaluation and Documentation of the	
A minimum of one (1) discretionary of "sidewall": sidewall candidates for least 12" in height. Instrumentation: Ludlum 2221 with 44-10 (2x2 NaI) collimation for investigations *Values based on information provi Scanning Minimum Detectable Con	detector; with Used f biased ded in HDP-TBD-FSS-6 centrations (MDC) for h	collected based on the following definition rtical or near vertical (> 45° angle) and a or GWS and to obtain static count rates a	
A minimum of one (1) discretionary of "sidewall": sidewall candidates for least 12" in height. Instrumentation: Ludlum 2221 with 44-10 (2x2 NaI) collimation for investigations *Values based on information provi Scanning Minimum Detectable Con for total Uranium reflects a conserv	detector; with Used f biased ded in HDP-TBD-FSS- centrations (MDC) for h ative assumption of 4%	collected based on the following definition rtical or near vertical (> 45° angle) and a or GWS and to obtain static count rates a measurement locations. 202, "Evaluation and Documentation of the Final Status Surveys (FSS). The Scan MD	
A minimum of one (1) discretionary of "sidewall": sidewall candidates for least 12" in height. Instrumentation: Ludlum 2221 with 44-10 (2x2 NaI) collimation for investigations *Values based on information provi Scanning Minimum Detectable Con for total Uranium reflects a conserver (2.0%) would result in Scan MDC variables	detector; with Used f biased ded in HDP-TBD-FSS- <i>centrations (MDC) for H</i> ative assumption of 4% alues slightly less than th	collected based on the following definition rtical or near vertical (> 45° angle) and a or GWS and to obtain static count rates a measurement locations. 002, "Evaluation and Documentation of the Final Status Surveys (FSS). The Scan MD enrichment. The actual RASS enrichment ose calculated for FSS planning purposes.	
A minimum of one (1) discretionary of "sidewall": sidewall candidates for least 12" in height. Instrumentation: Ludlum 2221 with 44-10 (2x2 NaI) collimation for investigations *Values based on information provi Scanning Minimum Detectable Conf for total Uranium reflects a conserve (2.0%) would result in Scan MDC va **IAL is the net count per minute (	detector, with Used f biased ded in HDP-TBD-FSS- <i>centrations (MDC) for I</i> ative assumption of 4% alues slightly less than th ncpm) equivalent of an	collected based on the following definition rtical or near vertical (> 45° angle) and a or GWS and to obtain static count rates a measurement locations. 2002, "Evaluation and Documentation of the Final Status Surveys (FSS). The Scan MD enrichment. The actual RASS enrichment ose calculated for FSS planning purposes.	
A minimum of one (1) discretionary of "sidewall": sidewall candidates for least 12" in height. Instrumentation: Ludlum 2221 with 44-10 (2x2 NaI) collimation for investigations *Values based on information provi Scanning Minimum Detectable Con for total Uranium reflects a conserv (2.0%) would result in Scan MDC var **IAL is the net count per minute ( Stratum DCGLw derived from the	detector; with Used f biased ded in HDP-TBD-FSS- centrations (MDC) for h ative assumption of 4% alues slightly less than th ncpm) equivalent of an a technical bases presente	collected based on the following definition rtical or near vertical (> 45° angle) and a or GWS and to obtain static count rates a measurement locations. 2002, "Evaluation and Documentation of the Final Status Surveys (FSS). The Scan MD enrichment. The actual RASS enrichment	

# 20.0 FINAL STATUS SURVEY IMPLEMENTATION LSA 12-05

FSS was performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.

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# 20.1 Gamma Walkover Survey

### 20.1.1 Instrumentation

The selected instrumentation to perform the GWS in LSA 12-05 was a 2" x 2" NaI detector in combination with a Ludlum 2221 rate meter. Each NaI instrumentation set was interfaced with a Trimble DGPS and handheld data logger.

Prior to the first field use of the GWS instrumentation, initial set-ups were performed. Also, daily pre- and post-use source checks were performed for each day that GWS was performed within the SU. Initial set-ups, daily source checks, and control charting were performed according to the requirements of HDP-PR-HP-416, *Operation of the Ludlum 2221 for Final Status Survey*.

# 20.1.2 GWS Performance

All GWS measurements on the excavation floor and sidewalls collected with the NaI detector(s) were connected to a Trimble DGPS and with a hand-held data logger. The logging frequency in the survey unit was 1 GWS measurement per second. Each gross gamma measurement is correlated to a set of coordinates based on the Missouri East State Plane, NAD 1983.

The GWS requirements involved moving the NaI detector in a side-to-side fashion no faster than 1 foot per second while holding the probe as close as possible to the excavation surface (nominally 1", but not to exceed 3"). At the same time, the technician was required to slowly advance, causing the detector to trace out a serpentine path over the excavation surface.

FSS Technicians performing GWS in LSA 12-05 used the 4,000 ncpm IAL as a field guide to know when to slow or pause the GWS for more deliberate investigation. If during the GWS, audible count rates noticeably increase above the general area average (i.e., > minimum detectable count rate), FSS Technicians were required to pause momentarily and observe count rates. If sustained count rates approached the IAL, further focused investigation was conducted within the locally elevated area.

To use the IAL effectively, FSS Technicians first determined the local background count rate before starting the GWS. Although the ambient gamma level may vary across the SU due to the geometry and relative distance from contaminated materials in nearby remedial excavations, the average background rate (measured at waist level) within the LSA ranged between 10,000 and 11,000 gcpm. Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 14,000 to 15,000 gcpm, FSS Technicians slowed or paused the GWS for more careful investigation of the small areas of elevated activity before deciding if "flagging" a point for potential biased sampling was warranted.

Hard to reach areas, and non-typical areas were surveyed manually as necessary in order to assess the potential for an area of elevated residual activity over 100% of the exposed ground surface.

After the GWS survey was complete, the GPS/GWS data was reviewed by Radiological Engineering and the Health Physics Technician performing the survey to determine if possible areas of elevated residual activity remained within the SU that required biased sample

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investigation. Areas that were flagged by the HP Technician were considered, as well as a statistical evaluation of the GWS data set. The statistical evaluation determined the mean count rate and standard deviation associated with the GWS and then could be used to identify any areas that exceeded 3 standard deviations above the mean. The number of biased samples to be collected and the locations are based on flagged locations exceeding the IAL, the statistical evaluation of the GWS data set, and the professional judgment of Radiological Engineering.

# 20.2 Soil Sampling

# 20.2.1 Systematic Soil Sampling Summary

Table 20-1 provides a summary of systematic sampling by stratum for LSA 12-05.

	Systematic Sampling Summary by Stratum for LSA 12-05							
LSA	SU Area,		Systematic					
	planar (m <sup>2</sup> )	Surface	Root	Deep (Excavation)	QC			
12-05	2,001	8	8	8*	2			

Table 20-1Systematic Sampling Summary by Stratum for LSA 12-05

\*Excavation samples were collected and archived, analysis only required if a overlying Root sample exceeds a 0.5 SOF

# 20.2.2 Systematic Sampling LSA 12-05

Within LSA 12-05, there were 8 systematic locations in which the surface stratum (0 - 15 cm) was sampled in the SU. The underlying root stratum was sampled at all 8 locations. Excavation stratum samples were collected and archived, but were not required to be analyzed since no root stratum sample exceeded a 0.5 Uniform SOF.

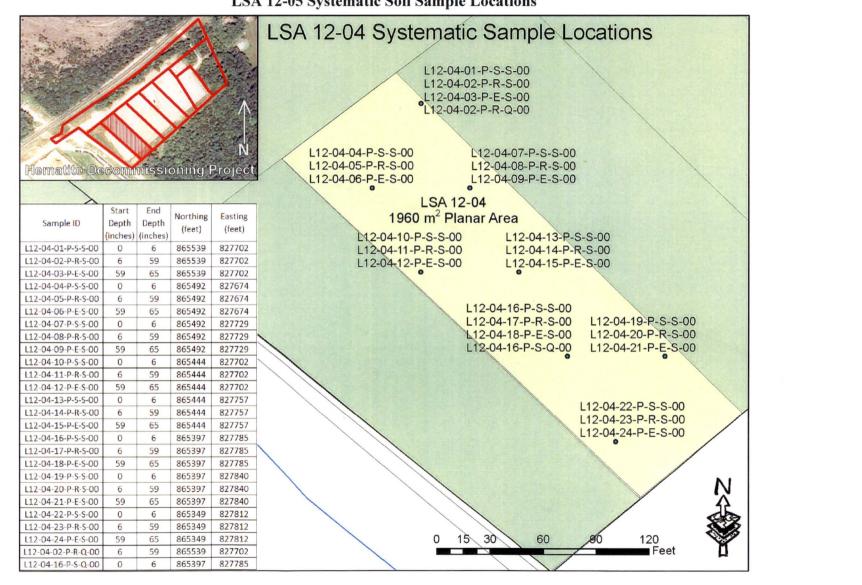
Given a planar area of 2,001  $\text{m}^2$  for LSA 12-05 and an eight - point systematic triangular grid, the point-to-point distance within each row was 16.9 m with spacing of 14.7 m between each of the parallel grid rows within the SU.

While there were eight (8) systematic locations on the LSA 12-05 sampling grid, a total of eighteen (18) samples were collected and analyzed at these locations, including:

- Eight (8) samples collected and analyzed within the surface stratum
- Eight (8) samples collected and analyzed within the root stratum
- Zero (0) samples analyzed within the excavation, or "deep" stratum
- Two (2) QC field replicate

Figure 20-1 presents the map of the eight systematic sample locations which were sampled within LSA 12-05. The inset table notes the location coordinates (Missouri East, NAD 1983) and collection intervals for each systematic location.

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Figure 20-1 LSA 12-05 Systematic Soil Sample Locations					



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Figure 20-2 below presents a tabular listing of all FSS samples collected within LSA 12-05 with associated IDs, sample types, collection intervals, coordinates, and notes.

	FSS	Sample		Figure 20- s and Coo		or LSA 12-	05	
Hematite Decommissioning Project		Procedure:	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development					
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	E	SS SAMPL		APPENDIX P-	-	DORDINATES		
Survey Area:	LSA		L & MLASON	Description:	monsace		rea, Plant Soils SEA	
	03		-	•				
Survey Unit:			-	Description:		,	Land Area in "Area 13"	
Survey Type:	FS	S	-	Classification	n:		Class 1	
Measurement or Sample ID	Surface or CSM	Туре	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes	
L12-05-01-P-S-S-00	Uniform	S	433.3	432.8	865565	827733	Surface 6-inch grab	
L12-05-02-P-R-S-00	Uniform	S	432.8	428.4	865565	827733	Root 59-inch composite	
L12-05-04-P-S-S-00	Uniform	S	432.2	431.7	865565	827788	Surface 6-inch grab	
L12-05-05-P-R-S-00	Uniform	S	431.7	427.2	865565	827788	Root 59-inch composite	
L12-05-07-P-S-S-00	Uniform	S	432.2	431.7	865517	827761	Surface 6-inch grab	
L12-05-08-P-R-S-00	Uniform	S	431.7	427.3	865517	827761	Root 59-inch composite	
L12-05-10-P-S-S-00	Uniform	S	431.4	430.9	865517	827816	Surface 6-inch grab	
L12-05-11-P-R-S-00	Uniform	S	430.9	426.5	865517	827816	Root 59-inch composite	
L12-05-13-P-S-S-00	Uniform	S	431.3	430.8	865468	827788	Surface 6-inch grab	
L12-05-14-P-R-S-00	Uniform	S	430.8	426.4	865468	827788	Root 59-inch composite	
L12-05-16-P-S-S-00	Uniform	S	431.1	430.6	865468	827844	Surface 6-inch grab	
L12-05-17-P-R-S-00	Uniform	S ·	430.6	426.2	865468	827844	Root 59-inch composite	
L12-05-19-P-S-S-00	Uniform	S	431.2	430.7	865420	827872	Surface 6-inch grab	
L12-05-20-P-R-S-00	Uniform	S	430.7	426.3	865420	827872	Root 59-inch composite	
L12-05-22-P-S-S-00	Uniform	S	428.9	428.4	865420	827927	Surface 6-inch grab	
L12-05-23-P-R-S-00	Uniform	S	428.4	423.9	865420	827927	Root 59-inch composite	
L12-05-08-P-R-Q-00	Uniform	Q	431.7	427.3	865517	827761	Root 59-inch composite	
L12-05-14-P-R-Q-00	Uniform	Q	430.8	426.4	865468	827788	Root 59-inch composite	
L12-05-25-P-S-B-00	Uniform	В	431.0	430.5	865345.0	827819.0	Biased 6-inch grab	

Green shaded samples are the samples at each sample location, for use in WRS Test.

\*Elevations are in feet above mean sea level.

\*\* Missouri - East State Plane Coordinates [North American Datum (NAD) 1983]

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R

 $CSM: \quad \mbox{Three-Layer (Surface-Root-Excavation) or Uniform DCGLs used}$ 

Type: Systematic = S, Biased = B; QC =Q; Investigation = I

Quality Record

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# 20.3 Biased Soil Sampling

As discussed in FSSFR Volume 3, Chapter 1, Section 6.1.3, there are three key methods for identifying areas for biased soil sampling, the IAL, the Z-score of the FSS GWS, and the professional judgment of the HP Staff. For LSA 12-05 one (1) biased sample location was selected within the SU based on the evaluation of the GWS survey data and HP Technician professional judgment. The biased location represented the maximum GWS measurement encountered within the SU. Biased samples are collected at the prescribed location to a depth of 6 inches below the exposed ground surface.

# 20.4 Judgmental/Sidewall Sampling for Tc-99

As an un-excavated SU, no Tc-99 sidewall sampling was necessary for LSA 12-05.

# 20.5 Quality Control Soil Sampling

Two QC field duplicate sample point were randomly selected and collected at systematic locations L12-05-08 and L12-05-14 for LSA 12-05.

# 21.0 FINAL STATUS SURVEY RESULTS LSA 12-05

# 21.1 Gamma Walkover Survey

Post-processed GPS coordinate data is accurate to within  $\pm 0.1$  m for the handheld GPS models used during the GWS. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same GPS location during the walkover, the most elevated radiological measurements are plotted "on top" (e.g. if any sidewalls featured more elevated readings than the floor directly below, the sidewall radiological measurements would overlie the lower floor readings).

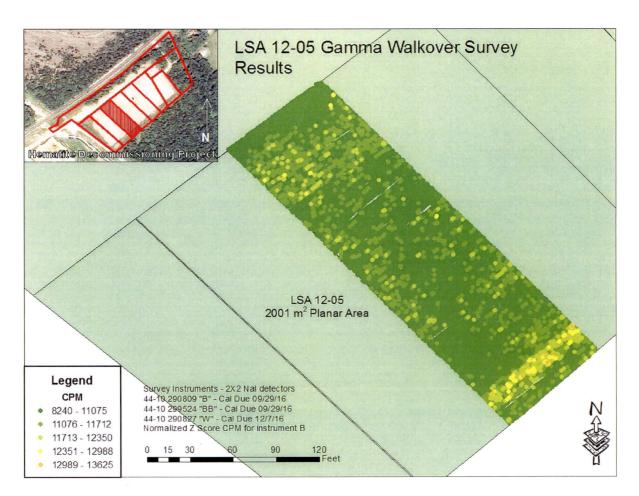
GWS measurements were collected in LSA 12-05 between May 6, 2016, and May 15, 2016.

# 21.1.1 GWS Results for LSA 12-05

For LSA 12-05, GWS count rates ranged between 8,240 gcpm and 13,238 gcpm, with a mean count rate of 10,437 gcpm. The median count rate was 10,739 gcpm and the standard deviation was 638 cpm. Figure 21-1 below presents a map of the complete GWS data set.

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Figure 21-1 Colorimetric GWS Plot for LSA 12-05

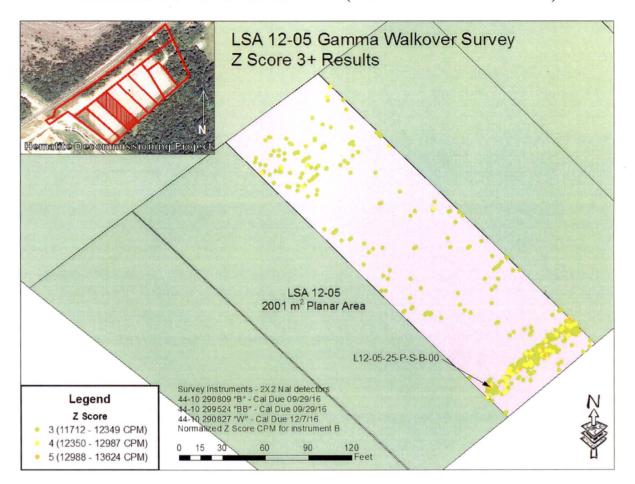


An evaluation of the entire GWS data set was performed to evaluate those small areas of elevated activity which exceeded three (3) standard deviations above the GWS mean measurement, (i.e., "+3 Z-score"). One location, L12-05-25 was selected for biased sample collection. The biased location represented the maximum GWS measurements encountered within the SU.

Figure 21-2 below presents a map of the +3 Z-score GWS measurements within LSA 12-05, including the selected biased sampling locations (ID: L12-05-25-P-S-B-00).

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Figure 21-2 Colorimetric GWS Plot for LSA 12-05 (Measurements > Z-score of 3)



All GWS data collected in LSA 12-05 was datalogged and post-processed in Graphical Information Software (GIS).

# 21.1.2 GWS Coverage Results LSA 12-05

FSSFR Volume 3, Chapter 1, Section 6.1.4, *Exposed Surfaces versus Accessible Surfaces*, provides a discussion and the criteria for evaluating the GWS coverage of a SU during FSS. Although 100% of accessible areas underwent GWS, the post survey processing of the GPS data indicated that the GWS covered 98.98% of the SU (see Table 21-1). As the evaluation indicates that the GPS coverage exceeded 95% with no readings approaching or exceeding the IAL of 4,000 net cpm in the vicinity of any apparent GPS coverage gaps, the GWS coverage for the SU has been evaluated to meet the intent of the "100% GWS coverage" requirement.

Hematite Decommissioning Project	FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12, Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)			
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# Table 21-1 GWS Gap Analysis LSA 10-04

	Total SU	GWS Gap	Gap	GWS	MARSSIM
	Pixels	Pixels	Percentage	Coverage	Class
LSA 12-05	155,934	1591	1.02	98.98	1

### 21.2 Soil Sample Results LSA 12-05

Appendix C presents the analytical results and associated statistics for all FSS surface samples collected within LSA 12-05.

#### 21.2.1 Surface Soil Sample Results LSA 12-05

There were eight systematic samples collected within the surface stratum (0 - 15 cm) of LSA 12-05. Additionally one biased sample was collected in the topmost layer of soil. The maximum Uniform SOF result for the surface samples was 0.33.

# 21.2.2 Subsurface Soil Sample Results LSA 12-05

There were eight systematic locations within LSA 12-05 where root stratum composite sampling was necessary. The root stratum zone is between 0.15 and 1.50 m below final grade surface. At each of the eight root stratum composite sampling locations, the top six inches (1.50 - 1.65 m below final grade surface) of the underlying excavation stratum was also collected and archived, however these excavation samples were not required to be analyzed as no overlying root stratum sample exceeded a 0.5 SOF. The maximum SOF result of the subsurface samples collected in LSA 12-05 was 0.11.

#### 21.2.3 WRS Evaluation

Per Step 7.8.3 of HDP-PR-FSS-721 *Final Status Survey Data Evaluation*, the Wilcoxon Rank Sum (WRS) statistical test was not required for LSA 12-05 since the difference between the maximum SU data set gross SOF and the minimum background area SOF was less than one using the Uniform Stratum criteria. However, for illustrative purposes, the WRS evaluation was still performed for LSA 12-05. All systematically collected samples regardless of depth are used to perform the WRS Test, however biased and QC sample results are not utilized in the WRS Test. The 16 systematically collected samples in LSA 12-05 were ranked against the adjusted activity concentrations of the 32 samples collected within the Background Reference Area. The SU passed the WRS Test since the ranked sum of the reference area ranks, or test statistic  $W_{R}$ , (1040) was greater than the critical value (860) for the test. As such, the null hypothesis that the SU average concentration is greater than the DCGL<sub>W</sub> was rejected. The WRS evaluation is also included in Appendix C.

# 21.2.4 Graphical Data Review LSA 12-05

Table 21-2 below presents summary results for the all systematically collected samples (includes surface, and root, but not biased or QC samples) collected within LSA 12-05, and the associated

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SOF when compared to the Uniform Stratum  $DCGL_ws$ . The arithmetic average concentration resulted in a SOF of 0.11.

Statistic	Ra-226 DCGL = 1.9 BKG = 1.07 (pCi/g)	Tc-99 DCGL = 25.1 (pCi/g)	Th-232 DCGL = 2.0 BKG = 1.0 (pCi/g)	U-234 DCGL=195.4 (pCi/g)	U-235 DCGL=51.6 (pCi/g)	U-238 DCGL=168.8 (pCi/g)	Sample SOF (Uniform DCGL)
Average	0.005	1.072	0.061	4.462	0.223	1.329	0.11
Minimum	0.00 ( <bkg)< td=""><td>0.00 (NEG)</td><td>0.00 (<bkg)< td=""><td>0.695</td><td>-0.116</td><td>0.695</td><td>0.01</td></bkg)<></td></bkg)<>	0.00 (NEG)	0.00 ( <bkg)< td=""><td>0.695</td><td>-0.116</td><td>0.695</td><td>0.01</td></bkg)<>	0.695	-0.116	0.695	0.01
Maximum	0.070	7.450	0.170	11.292	0.622	2.870	0.33

# Table 21-2 LSA 12-05 FSS Sample Data Summary and Calculated SOF Values (Systematic)

Notes:

1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.

2. Average SOF for data set calculated using average radionuclide concentrations.

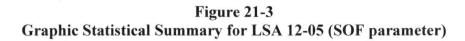
3. U-234 values are inferred from the U-235/U-238 ratio.

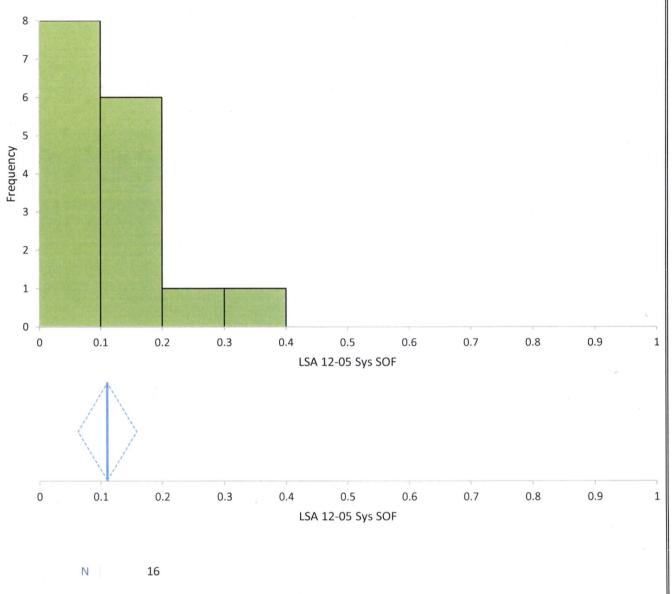
Section 8.2.2.2 of MARSSIM recommends a graphical review of FSS analytical data, to include at a minimum, a posting plot and a histogram. A frequency plot, or histogram, is a useful tool for examining the general shape of a data distribution. This plot is a bar chart of the number of data points within a certain range of values. The frequency plot will reveal any obvious departures from symmetry, such as skewness or bimodality (two peaks), in the data distribution for the survey unit. The presence of two peaks in the survey unit frequency plot may indicate the existence of isolated areas of residual radioactivity.

Figure 21-3 presents the overall statistical metrics for the SOF parameter for the 16 systematically collected samples from LSA 12-05. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 12-05. The middle graph presents the mean SOF (0.11) as indicated by the blue vertical line) of the sample population and the 95% confidence interval of the mean SOF represented by the blue diamond which is 0.06 to 0.16. The 97.87% confidence interval based on the median (0.10) of the sample results is 0.04 to 0.14. The bottom two charts present the various statistical metrics of the LSA 12-05 SOF data set, including the mean, median, standard deviation, minimum, maximum, confidence intervals, etc.

Figure 21-3 exhibits no unusual symmetry or bimodality concerns for the LSA 12-05 data associated with the systematically collected measurement locations.

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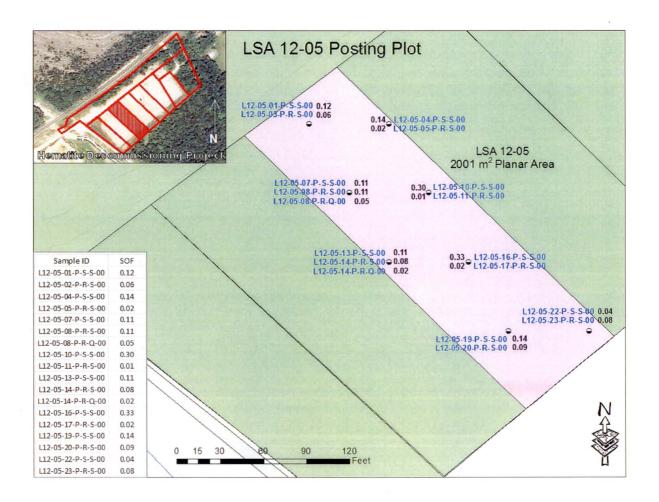


	Mean	95%	6 CI	Mean SE	SD	Variance	Skewness	Kurtosis
LSA 12-05 Sys SOF	0.11	0.06	to 0.16	0.022	0.09	0.01	1.5	2.22
		1st				3rd		
	Minimum	quartile	Median	97.87	'% CI	quartile	Maximum	IQR
LSA 12-05 Sys SOF	0.01	0.05	0.10	0.04	to 0.14	0.13	0.3	0.08

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A posting plot is simply a map of the survey unit with the data values (in this case the SOF values for each systematically collected sample) entered at the measurement locations. This potentially reveals heterogeneities in the data – especially possible patches of elevated residual radioactivity. The posting plot for LSA 12-05 is presented below in Figure 21-4. Figure 21-4 shows no unusual patterns in the data.

Figure 21-4 Posting Plot for LSA 12-05 Systematic Measurement Locations



Appendix C to this report presents the complete analytical data set (in Microsoft Excel format) used to derive the summary statistics presented in Table 21-2, Figure 21-3, and Figure 21-4 above. A summary of the analytical data is presented in Table 21-3 below. Appendix Q to this report presents the TestAmerica Analytical Laboratory soil sample reports.

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												F	inal S	Status		Table y Anal		l Data:	LSA	12-05													
	c,	QC)													TestA	merica A	nalytic	al Result	S														
<u>e</u>	pth (f	as,			Ra-2	226					Тс-99					Th-2	32			In	ferred	U-234			U-23	5			U-2	38		Enr.	SOF
Sample ID	Sample Depth (ft)	Type (Systematic, Bi	Result	Uncertainty	MDC	Qualifier	Net Result*	Corrected Result	Result	Corrected Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Net Result**	Corrected Result	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Enrichment (%)	SOF
L12-05-01-P-S-S-00	0.00	S	0.751	0.128	0.103	N/A	-0.319	0.000	1.09	1.090	0.103	0.238	N/A	1.04	0.159	0.107	N/A	0.040	0.040	7.502	NA	NA	NA	0.414	0.173	0.215	N/A	1.21	0.352	0.883	N/A	5.1	0.12
L12-05-02-P-R-S-00	0.50	S	0.837	0.119	0.0682	N/A	-0.233	0.000	0.053	0.053	0.114	0.221	U	1.08	0.159	0.103	N/A	0.080	0.080	2.175	NA	NA	NA	0.116	0.244	0.491	U	1.1	0.305	0.742	N/A	1.7	0.06
L12-05-04-P-S-S-00	0.00	S	0.911	0.148	0.0749	N/A	-0.159	0.000	0.874	0.874	0.181	0.231	N/A	1.08	0.173	0.106	N/A	0.080	0.080	8.624	NA	NA	NA	0.475	0.169	0.203	N/A	2.19	0.626	0.864	N/A	3.3	0.14
L12-05-05-P-R-S-00	0.50	S	0.798	0.119	0.0685	N/A	-0.272	0.000	0.0069	0.007	0.129	0.231	U	0.928	0.152	0.115	N/A	-0.072	0.000	2.787	NA	NA	NA	0.153	0.106	0.158	U	0.811	0.286	0.719	N/A	2.9	0.02
L12-05-07-P-S-S-00	0.00	S	0.812	0.128	0.075	N/A N/A	-0.258	0.000	1.34 0.102	1.340 0.102	0.228	0.242	N/A U	0.912	0.167	0.0952	N/A N/A	-0.088 0.160	0.000	7.200 2.317	NA	NA	NA NA	0.397	0.189	0.215	N/A U	1.72	0.612	0.89	N/A N/A	3.5 1.6	0.11
L12-05-08-P-R-S-00	0.50	S S	0.824	0.154	0.0724	N/A	-0.246	0.000	5.23	5.230	0.042	0.221	N/A	0.919	0.139	0.0679	N/A	-0.081	0.000	11.292	NA	NA	NA	0.622	0.0987	0.194	N/A	2.87	0.615	0.762	N/A	3.3	0.11
L12-05-10-P-S-S-00 L12-05-11-P-R-S-00	0.00	S	0.804	0.134	0.0774	N/A	-0.266	0.000	0.0658	0.066	0.05	0.227	U	0.921	0.143	0.101	N/A	-0.079	0.000	0.695	NA	NA	NA	-0.024	0.152	0.377	U	0.695	0.284	0.764	U	0.7	0.01
L12-05-13-P-S-S-00	0.00	S	1.14	0.17	0.0773	N/A	0.070	0.070	0.272	0.272	0.082	0.243	N/A	1.02	0.172	0.133	N/A	0.020	0.020	7.160	NA	NA	NA	0.395	0.154	0.19	N/A	1.66	0.547	0.775	N/A	3.6	0.01
L12-05-14-P-R-S-00	0.50	S	1.01	0.145	0.0695	N/A	-0.060	0.000	0.0287	0.029	0.065	0.239	U	1.14	0.183	0.122	N/A	0.140	0.140	1.293	NA	NA	NA	0.0673	0.241	0.485	U	0.838	0.289	0.738	N/A	1.3	0.08
L12-05-16-P-S-S-00	0.00	S	0.828	0.117	0.0518	N/A	-0.242	0.000	7.45	7.450	0.727	0.217	N/A	0.789	0.134	0.0827	N/A	-0.211	0.000	4.563	NA	NA	NA	0.251	0.105	0.164	N/A	1.26	0.291	0.679	N/A	3.1	0.33
L12-05-17-P-R-S-00	0.50	S	0.823	0.12	0.0616	N/A	-0.247	0.000	0	0.000	0	0.234	U	0.958	0.156	0.0772	N/A	-0.042	0.000	1.841	NA	NA	NA	0.0999	0.184	0.336	U	0.698	0.266	0.702	U	2.2	0.02
L12-05-19-P-S-S-00	0.00	S	0.859	0.141	0.066	N/A	-0.211	0.000	0.368	0.368	0.186	0.25	N/A	1.14	0.21	0.134	N/A	0.140	0.140	7.586	NA	NA	NA	0.419	0.184	0.219	N/A	1.36	0.361	0.849	N/A	4.6	0.14
L12-05-20-P-R-S-00	0.50	S	0.919	0.131	0.058	N/A	-0.151	0.000	0.0092	0.009	0.046	0.23	U	1.17	0.195	0.103	N/A	0.170	0.170	0.912	NA	NA	NA	-0.116	0.0871	0.493	U	0.912	0.475	0.74	N/A	0.7	0.09
L12-05-22-P-S-S-00	0.00	S	0.868	0.133	0.0695	N/A	-0.202	0.000	0.233	0.233	0.091	0.248	U	0.912	0.182	0.106	N/A	-0.088	0.000	4.158	NA	NA	NA	0.227	0.161	0.196	N/A	1.43	0.715	0.875	N/A	2.5	0.04
L12-05-23-P-R-S-00	0.50	S	1.03	0.172	0.0921	N/A	-0.040	0.000	0.0365	0.037	0.055	0.243	U	1.14	0.184	0.117	N/A	0.140	0.140	1.290	NA	NA	NA	-0.055	0.144	0.604	U	1.29	0.584	0.884	N/A	0.7	0.08
L12-05-08-P-R-Q-00	0.50	Q	1.04	0.165	0.0771	N/A	-0.030	0.000	0.139	0.139	0.04	0.235	U	1.05	0.19	0.133	N/A	0.050	0.050	2.491	NA	NA	NA	0.136	0.287	0.559	U	0.263	0.169	1.28	U	7.5	0.05
L12-05-14-P-R-Q-00	0.50	Q	1.07	0.155	0.0519	N/A	0.000	0.000	0.0284	0.028	0.013	0.219	U	0.775	0.247	0.221	N/A	-0.225	0.000	1.719	NA	NA	NA	0.0877	0.352	0.586	U	1.24	0.356	0.899	N/A	1.1	0.02
L12-05-25-P-S-B-00	0.00	В	0.930	0.137	0.067	N/A	-0.140	0.000	0.306	0.306	0.123	0.223	N/A	1.020	0.173	0.102	N/A	0.020	0.020	1.070	NA	NA	NA	-0.020	0.045	0.543	U	1.070		0.796	N/A	0.7	0.03
Systematic Mi					0.00						0.000					0.00					0.69				-0.11				0.69			2.6	0.01
Systematic Ma		1			0.07						7.450					0.17					11.29				0.62				2.8			age ent (%)	0.33
Systematic M	and the second				0.00						1.072					0.06					4.46				0.22				1.32			L'E	0.11
Systematic M					0.00						0.168					0.03					3.47				0.19				1.24			Av	0.10
Systematic Standar	rd Deviati	on	10/345	areau 4h	0.0			4.07			2.137	_		Those	hlen -	0.06	68				3.30	9			0.21	2			0.57	75		Ш.	0.09
			with in	growth, u	se Ra226	o bkg =	al and a second	1.07		1.1.1.1.		2. 4. 2		Th232	bkg =	1.0															No. of the		

NOTES:

Gross results in units of pCi/g.

\* Background with ingrowth (1.07 pCi/g) subtracted from gross result.

\*\*Background (1.0 pCi/g) subtracted from gross result.

U Qualifier: Result is less than the sample detection limit.

All uncertainty values are reported at the 2-sigma confidence level.

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### 21.2.5 Biased Soil Sample Result LSA 12-05

One (1) biased sample was collected from LSA 12-05. The sample collected at location L12-04-25 represented the maximum GWS measurement (13,238 gcpm) within the SU, and had a result of 0.03 Uniform SOF.

# 21.2.6 Quality Control Soil Sample Result LSA 12-05

Two QC field duplicate sample points were randomly selected for LSA 12-05 which were collected at systematic locations L12-05-08 and L12-05-14.

For the 17 samples (i.e., 16 systematic + 1 biased) collected within LSA 12-04, two field duplicate samples were collected. This frequency equates to 11.8%, (i.e. 2/17). Form HDP-PR-FSS-703-1 documents that the duplicate sample result comparison with the partner's sample results that all comparison criteria were less than the calculated warning limits (see Figure 21-5 below).

The statistical assessment of the Laboratory QC sample results indicated that one field duplicate sample exceeded the calculated Warning Limit, but was less than the calculated Control Limit. The one sample result that exceeded the Warning Limit was sample L12-05-14-P-R-S-00 for Th-232. In accordance with procedure HDP-PR-FSS-703, when an exceedance occurs an investigation is performed to determine if corrective actions were necessary. The investigation determined that for Th-232 the calculated statistic (0.323) only slightly exceeded the calculated Warning Limit (0.283). Also, considering the low activity and the errors associated with the sample results, the Th-232 activity of both samples were relatively close. Based upon the investigation of the exceedance and the results of previous Quality Assurance audits of the overall performance of the laboratory, no corrective actions were determined to be necessary.

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,	Form HI	DP-PR-FS	S-703-1 F		Figure 21 uplicate Sa		ssessment I	LSA 12-(	)5 (1 of :	2)		
Hematite	Procedure: HDP-PR-	-FSS-703, Fin	al Status Sur	vey Qua	lity Control				<u> </u>			
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	<u></u>		FIE		FORM HDP-H PLICATE SA		D3-1 SSESSMENT	. <u>.</u>		<u> </u>	<u> </u>	
Survey Unit No.:	LSA 12-05				Survey Unit D	escription:	Class I Laydow	n Land Are	a in "Area	13"		
	Field Duplicate		Sample (p		Field Duplica (pCi/	g)	Average Activity $(\bar{\chi})$	Nuclide DCGL	3	Warning		Statistic Exceeds Limit?
Sample ID	Sample ID	Radionuclide		MDC 0.0724	Activity $(x_i)$	MDC	(pCi/g)	(pCi/g)	Statistic <sup>2</sup>	Limit	Limit	(Y/N)
L12-05-08-P-R-S-00 L12-05-08-P-R-S-00	L12-05-08-P-R-Q-00 L12-05-08-P-R-Q-00	Ra-226 Tc-99	1.08 0.102	0.0724	1.04 0.139	0.0771	1.060 0.121	1.9 25.1	0.04 NA	0.269	0.403	N NA
L12-05-08-P-R-S-00	L12-05-08-P-R-Q-00	Th-232	1.16	0.221	1.05	0.133	1.105	2.0	0.110	0.283	0.424	NA
L12-05-08-P-R-S-00	L12-05-08-P-R-Q-00	U-234 <sup>1</sup>	2.317	0.15 N/A	2.491	0.155 N/A	2.404	195.4	0.173	27.649	41.425	N
L12-05-08-P-R-S-00	L12-05-08-P-R-Q-00	U-235	0.123	0.181	0.136	0.559	0.130	51.6	NA	7.301	10.939	NA
L12-05-08-P-R-S-00	L12-05-08-P-R-Q-00	U-238	1.22	0.777	0.263	1.28	0.742	168.8	NA	23.885	35.786	NA
Performed by: $\mathcal{T}_{\mathcal{A}}$	to MDC available. Int is not necessary if the $h \circ m + s = \int c \cdot r \cdot \frac{1}{r} \frac{1}{r}$		-	4DC.			Reviewed by:	,	ant Eve	sh	). CL	L
Quality Record	<u>1-23-16</u>						Date: 11/0	<u> </u>				

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	Form H	DP-PR-FS	S-703-1 F	field D	Figure 21 uplicate Sa		ssessment I		)5 (2 of 2	2)		
Hematite	Procedure: HDP-PR-	-FSS-703, Fin	al Status Su	rvey Qua	lity Control		n			· ····		
Decommissioning Project								Revisi	on: 2		Page 1	of l
	· <u>·</u>		FII		FORM HDP-I PLICATE SA		)3-1 SSESSMENT		<u>, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10</u>	<u> </u>		
Survey Unit No.:	LSA 12-05				Survey Unit D	escription:	Class I Laydow	n Land Are	a in "Area	13"		
3	Field Duplicate		Sample (pCi/g)		Field Duplica (pCi/	g)	Average Activity $(\vec{x})$	Nuclide DCGL		Warning		-Statistic Exceeds Limit?
Sample ID L12-05-14-P-R-S-00	Sample ID L12-05-14-P-R-Q-00	Radionuclide Ra-226	Activity (x <sub>i</sub> )	MDC 0.0695	Activity (x <sub>i</sub> ) 1.07	MDC 0.0519	(pCi/g) 1.040	(pCi/g) 1.9	Statistic <sup>2</sup> 0.06	Limit 0.269	Limit 0.403	(Y/N) N
	L12-05-14-P-R-Q-00	Tc-99	0.0287	0.0095	0.0284	0.0319	0.029	25.1	0.00 NA	3.552	5.321	NA
L12-05-14-P-R-S-00	L12-05-14-P-R-Q-00	Th-232	1.14	0.122	0.775	0.221	0.958	2.0	0.365	0.283	0.424	Y
L12-05-14-P-R-S-00	L12-05-14-P-R-Q-00	U-234 <sup>1</sup>	1.293	N/A	1.719	N/A	1.506	195.4	0.426	27.649	41.425	N
L12-05-14-P-R-S-00	L12-05-14-P-R-Q-00	U-235	0.0673	0.485	0.0877	0.586	0.078	51.6	NA	7.301	10.939	NA
L12-05-14-P-R-S-00	L12-05-14-P-R-Q-00	U-238	0.838	0.738	1.24	0.899	1.039	168.8	0.402	23.885	35.786	·N
Performed by: 71	o MDC available. Int is not necessary if the $\frac{7}{1-2} = \frac{7}{16}$			MDC.			Reviewed by: Date: ///2	<u>W. C</u> 3/16	Ionh Er	reyh	). UL	E-
Quality Record	<u>// - 2 3 / 2</u> ,						<u>Date. 1110</u>	, <u>, , , , , , , , , , , , , , , , , , </u>				

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# 21.3 Tc-99 Hot Spot Assessment LSA 12-05

There is no historical sampling data available for this area since it was always considered a nonimpacted area prior to the storage of potential reuse soils within the LSA. As a previously unimpacted area there is no history of a Tc-99 sample result ever exceeding the Tc-99 Uniform  $DCGL_w$ , as only potential reuse soil was placed within the LSA. The highest Tc-99 sample result collected from both Final RASS and FSS was 7.45 pCi/g. Therefore there is no concern for a potential Tc-99 hot spot exceeding the  $DCGL_w$  of 25.1, and there is no reason to perform a Tc-99 hot spot assessment.

#### 22.0 ALARA EVALUATION LSA 12-05

All samples collected within LSA 12-05 were evaluated against the Uniform Stratum DCGL<sub>w</sub>. For LSA 12-05 no sample result exceeded a SOF of 1.0. The average SOF result, based on all systematically collected samples, was 0.11 for LSA 12-05. The average SOF equates to residual activity contributions from the survey unit area of 2.75 mrem/yr for LSA 12-05. Groundwater Monitoring Well data provided in FSSFR Volume 6, Chapters 2 and 3 {ML16287A528} and Chapter 4 {ML16342B552}, indicate that the groundwater dose contribution will be a fraction of the MCLs. Nevertheless, a maximum groundwater contribution assumption of 4.0 mrem/yr based upon the EPA MCLs will be added to the total estimated dose for LSA 12-05. Adding these dose contributions together, the total estimated dose for LSA 12-05 is 6.75 mrem/yr.

Since the estimated Total Effective Dose Equivalent is well below the regulatory release criterion of 25 mrem/yr, the conclusion of the ALARA evaluation is that the FSS of LSA 12-05 was successful and that there would be no discernable benefit to the health and safety of the public in attempting to further reduce the results of FSS by performing remediation of LSA 12-05.

# 23.0 FSS PLAN DEVIATIONS LSA 12-05

#### 23.1 Remedial Actions during FSS

There was no remedial action in LSA 12-05.

# 23.2 Adjustments to Scan MDC Calculations

Scan MDCs for LSA 12-05 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD- FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. The assumed LSA background count rate of 10,000 cpm was applied to determine the prospective Scan MDCs, and the actual mean count rate from the FSS survey was 10,437 cpm. Therefore the calculated Scan MDCs are appropriate, and no adjustments need to be made.

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# 24.0 DATA QUALITY ASSESSMENT

The DQO process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process are presented in Volume 3, Chapter 1, Section 4.0 of the FSSFR and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

# 24.1 Data Quality Assessment for LSA 12-05

The Data Quality Assessment of the survey methodology, sampling and sample analysis results, and the Quality Control sampling and analysis results to ascertain the validity of the conclusion for LSA 12-05 (see Figure 24-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-416 (*Operation of the Ludlum 2221 for Final Status Survey*).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.
- The systematic samples that were collected (on a random-start triangular grid) and the gamma scan surveys that were conducted were performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.
- All samples sent for analysis at the approved offsite laboratory (TestAmerica) were tracked on a chain of custody form in accordance with HDP-PR-QA-006, *Chain of Custody*.
- Quality Control sample results were verified to meet the acceptance criteria as specified in HDP-PR-FSS-703, *Final Status Survey Quality Control*.
- LSA 12-05 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.
- The WRS Test is not necessary when the difference between the maximum survey unit data set measurement SOF and the minimum background area measurement SOF is less than or equal to one. For LSA 12-05, no individual gross SOF result in the FSS data set exceeded the SOF of the minimum background reference area measurement by more than one using the Uniform Stratum criteria. Therefore, the WRS Test was not required for LSA 12-05. However the WRS Test was still performed for illustrative purposes. Since the test statistic, WR (1040) exceeded the critical value (860), the FSS data set passed the WRS Test and the null hypothesis was rejected. The WRS Test worksheet is presented in Appendix C.
- A biased soil sample was collected from the location of the highest gamma count rate within the SU, and the result was a 0.03 Uniform SOF.

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	The maximum SOF result for all surface samples within The maximum SOF result for all subsurface samples within The average SOF result for all systematically collected samp was 0.11, with an upper 95% confidence level (UCL <sub>mean</sub> 0.9	n LSA 12-05 was 0.11. ples within LSA 12-05
	No FSS sample result in LSA 12-05 exceeded a SOF of 1 Uniform Stratum criteria, therefore an EMC or supplement not required. For the same reason, no comparisons to the a multi-CSM (i.e. Surface, Root and Excavation) DCGLs wer	ntal investigations was lternate "Three-Layer"
	A retrospective sampling frequency evaluation was perform sufficient statistical power exists to reject the null hypother number (8) of systematic samples actually collected with successful result of the retrospective power evaluation prese LSA 12-05 indicates that the minimum number of sample WRS Test were equal to the number of sampling locati within LSA 12-05. The methodology used for the refrequency evaluation is similar to the prospective samp performed during FSS Plan Development except that actuant and statistics are used in the sample size verification. Spect standard deviation of the eight LSA surface samples (i.e., data set) are used to derive the relative shift for each LSA. and Type II errors of 0.05 and 0.10, respectively, the calcu- then correlated to a minimum sample size number as pro- MARSSIM.	esis based on the total hin LSA 12-05. The ented in Table 24-1 for es required (8) for the ons actually collected etrospective sampling ble size determination hal FSS sample results cifically, the mean and the WRS Test sample Given the HDP Type I culated relative shift is
	HDP staff ensured that a visual inspection of the SU con Isolation & Control measures were performed periodicall there were no instances of potential cross contamination fro the FSS of all remaining areas at HDP were completed.	y, and confirmed that

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Table 24-1	
<b>Retrospective Sample Size Verification for LSA</b>	12-05

L Criteria Evaluation
ue Verification
SOF (Ra/Tc/Th/Iso U)
0.09
1
0.11
0.89
9.91
1.000000
12
14.4
8
8
SUFFICIENT MEASUREMENTS

"N/2" Corresponds to the number of survey unit measurement locations required for the WRS Test

MARSSIM Table 5.1						
Δ/σ	Pr					
0.1	0.528182					
0.2	0.556223					
0.3	0.583985					
0.4	0.611335					
0.5	0.638143					
0.6	0.664290					
0.7	0.689665					
0.8	0.714167					
0.9	0.737710					
1.0	0.760217					
1.1	0.781627					
1.2	0.801892					
1.3	0.820978					
1.4	0.838864					
1.5	0.855541					
1.6	0.871014					
1.7	0.885299					
1.8	0.898420					
1.9	0.910413					
2.0	0.921319					
2.25	0.944167					
2.5	0.961428					
2.75	0.974067					
3.0	0.983039					
3.5	0.993329					
4.0	0.997658					
4.01	1.000000					

#### MARSSIM Table 5.2, $\alpha = 0.05$ , $\beta = 0.10$

α

α (or β)	$Z_{1-\alpha}$ (or $Z_{1-\beta}$ )					
0.005	2.576					
0.01	2.326					
0.015	2.241					
0.025	1.960					
0.05	1.645					
0.10	1.282					
0.15	1.036					
0.2	0.842					
0.25	0.674					
0.30	0.524					

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	Data	Evaluation Chec	Figure 24 klists prepare:		-05 (page	1 of	2)
	mutito	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation					
Hematite Decommissioning Project					Revision:		Appendix G-1, Page 1 of 2
	FINAL	STATUS SURVEY D	APPENDIX ( ATA QUALITY C		VIEW CHE	CKLI	ST
	vey Area: vey Unit:	LSA 12 05		Laydown Area, l Class 1 Laydown			ea 13"
1.	Have all m to data ana	leasurements and/or an lysis for FSS been ind with Section 8.1 of thi	alysis results that violated	will be subjected	Yes 🔀	No 🗌	
2.		systematic measureme the locations specifie s?			Yes 🔀	No 🗌	]
3.		ave all scans surveys been performed of the areas specified as Yes Xes No Average Yes Yes Yes Yes Yes Yes Yes Yes Yes Ye					]
4.		Have all biased measurements and/or samples been taken or acquired at the locations specified in the FSSP & the FSS Sample Instructions?				No	] NA 🗌
5.		ve duplicate and/or split samples or measurements been taken or uired at each location designated as a QC sample?			Yes 🔀	No	] NA 🗌
6.	capable of	instruments used to m detecting the ROCs o riate investigation level	r gross activity at a		Yes 🔀	No [	]
7.	analyze da	alibration of all instrur ta, current at the time using a NIST traceable	of use and were the		Yes 🔀	No 🗌	]
8.		nstruments successfull lired, after use on the date			Yes 🔀	No 🗌	]
9.	Do the sam	ples match those ident	ified on the chain of	f custody?	Yes 🔀	No	] NA 🗌
10	Do the QC	Sample Results meet t SS-703, Final Status S	he acceptance criter	ia as specified in	Yes ⊠*	No 🗌	]
10.							

Comments: \*One QC duplicate sample L12-05-14-P-R-Q-00 exceeded Warning Limit for Th-232, but did not exceed Control Limit, results acceptable.

Quality Record

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Hematite	Procedure: HDF	-PR-FSS-7	21, Final Statu	s Survey D	ata Evali	uation	
Project						Revision: 10	Appendix G-1, Page 2 of 2
FINAL	STATUS SURV		APPENDIX ( QUALITY O		ES REV	IEW CHECH	KLIST .
Survey Area:	LSA 12		Description:	Laydown	ı Area, P	lant Soils SEA	A
Survey Unit:	05					Land Area in	
Discrepancy:	N/A						·····
						<u> </u>	
· · · · · · · · · · · · · · · · · · ·						<u></u>	
Corrective Act	ons Taken: <u>N/A</u>						
Corrective Act		<u> </u>					
Corrective Act		<u> </u>					
Corrective Act		<u> </u>					
Corrective Act		<u> </u>					
	ons Taken: <u>N/A</u>	· · · · · · · · · · · · · · · · · · ·					Io 🗌 NA 🕅
11. Have the		resolved th	e discrepancy v				io 🗌 NA 🔀
11. Have the a. If "No"	ons Taken: <u>N/A</u>	resolved th s form to th	e discrepancy ne RSO.	with the dat			Io 🗌 NA 🕅
11. Have the a. If "No 12. The follow	ons Taken: <u>N/A</u> corrective actions ', then forward the wing questions wi nswer to questions	resolved th s form to th	e discrepancy the RSO. red by the RSC	with the dat	ta?	Yes 🗌 N	
11. Have the a. If "No 12. The follor a. If the a still va b. If "No	ons Taken: <u>N/A</u> corrective actions ', then forward the wing questions wi nswer to questions	resolved th s form to th II be answer 11 was "N iting valid r	e discrepancy ne RSO. red by the RSC o", then is the neasurements of	with the dat ). affected dat or samples	ta?	Yes 🗌 N Yes 🗍 N	
11. Have the a. If "No" 12. The follow a. If the a still va b. If "No" sufficie c. If "No"	ons Taken: <u>N/A</u> corrective actions ', then forward th wing questions wi nswer to question lid? ', then are the exis	resolved th s form to th ll be answer 11 was "N ting valid r compliance cquisition of	e discrepancy e discrepancy a RSO. red by the RSC o", then is the neasurements of e for the surves of additional m	with the dat ). affected dat or samples y unit?	ta?	Yes 🗌 N Yes 🗌 N Yes 🗌 N	10 🗌 NA 🕅
<ul> <li>11. Have the</li> <li>a. If "No"</li> <li>12. The follow</li> <li>a. If the a still va</li> <li>b. If "No" sufficie</li> <li>c. If "No" demon</li> </ul>	ons Taken: <u>N/A</u> corrective actions ', then forward the wing questions wi nswer to question lid? ', then are the exist ent to demonstrate ', then direct the a	resolved th s form to th ll be answer 11 was "N ting valid r compliance cquisition of	e discrepancy e discrepancy a RSO. red by the RSC o", then is the neasurements of e for the surves of additional m	with the dat ). affected dat or samples y unit?	ta?	Yes 🗌 N Yes 🗌 N Yes 🗌 N	10 🗌 NA 🕅

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#### 25.0 CONCLUSION LSA 12-05

An adequate quantity and quality of radiological surveys and samples, as well as the corresponding laboratory analysis has been performed, evaluated and documented to demonstrate that the dose associated with all sources within SU LSA 12-05 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402.

	LSA 12-05 SOF and Dose Summation								
	AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	BURIED PIPING	REUSE SOIL	TOTAL			
SOF	0.11	N/A	0.16	N/A	N/A	0.27			
DOSE	2.75 mrem/year	N/A	4.0 mrem/year	N/A	N/A	6.75 mrem/year			

Table 25-1LSA 12-05 SOF and Dose Summation

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#### 26.0 FINAL STATUS SURVEY DESIGN LSA 12-06

This section of the report describes the method for determining the number of samples required for the FSS of LSA 12-06 as well as summarizing the applicable requirements of the FSS Plan. These include the DCGL<sub>W</sub>, scan survey coverage, and IAL. The radiological instrumentation used in the FSS of LSA 12-06 and the detection sensitivities are also discussed.

#### 26.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 12-06 were driven by the type (Open Land) and Class (Class 1) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development*, November 2015.

#### 26.1.1 Surrogate Evaluation Areas

A discussion of Surrogate Evaluation Areas is given in the FSSFR Volume 3, Chapter 1, Section 5.0, *Final Status Survey Design*.

## 26.1.2 DCGL<sub>w</sub>

During the FSS design process a review was performed of the RASS data for LSA 12-06. The RASS data was used as confirmation that no known areas of residual radioactivity remained within the survey areas that exceeded the Uniform Stratum  $DCGL_w$ . Therefore the Uniform Stratum  $DCGL_w$  was selected for use in demonstrating compliance with the release criteria.

#### 26.1.3 GWS Coverage

As a Class 1 SU, LSA 12-06 was required to undergo a 100% GWS.

#### 26.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 12-06 was the Ludlum 44-10 2" x 2" NaI detectors, coupled to a Ludlum 2221 scaler-ratemeter.

#### 26.1.5 Scan Minimum Detectable Concentration

Scan MDCs for LSA 12-06 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD- FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. As background levels were approximately 10,000 cpm within LSA 12-06, the scan MDC calculation for total uranium given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.2.6.d, was applied:

Scan MDC (total uranium) = 
$$\frac{1}{\left(\left(\frac{f_{U-234}}{3659 \ pCi/g}\right) + \left(\frac{f_{U-235}}{2.32 \ pCi/g}\right) + \left(\frac{f_{U-238}}{30.6 \ pCi/g}\right)\right)}$$

Equation 26-1

To determine isotopic Uranium fractions HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* assumes that the average LSA enrichment is 4% or less. Based on the

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systematically collected RASS samples in LSA 12-06, the average enrichment for the SU was 2.96%. All other Scan MDC parameters agreed upon between Westinghouse and the NRC were applied (e.g. use of a 2 in air gap, scan rate of 1 ft/sec, 0.75 surveyor efficiency), therefore no subsequent changes to the calculated Scan MDCs need to be made.

Prospectively calculated Scan MDCs for 2" x 2" NaI detectors that were used in LSA 12-06 are shown below:

# Table 26-1Scan MDCs for 2" x 2" NaI detector, 10,000 cpm background: LSA 12-06

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 12-06	40.9	46.6	0.87	2.8	1.21	3.0

\*DCGL<sub>w</sub> includes background concentrations of 0.9 pCi/g for Ra-226 (no ingrowth) and 1.0 pCi/g for Th-232. DCGLw values are based on the Uniform Stratum release criteria.

The values in Table 26-1 reflect those presented in the FSS Plans prepared for the SU prior to FSS.

#### 26.1.6 Investigation Action Level

FSSFR Volume 3, Chapter 1, Section 6.1.3, *Investigation Action Level (IAL)*, provides a discussion in regards to the IAL. The basis of the IAL is detailed in HDP memorandum, HEM-15-MEMO-021 "Evaluation of the Scan IAL for Class 1 areas at the Westinghouse Hematite Site". The IAL used during the GWS of LSA 12-06 was established at 4,000 ncpm.

#### 26.1.7 LSA 12-06 FSS Design Summary

The FSS Plans for LSA 12-06 can be found in Appendix K. Table 26-2 presents an overall FSS design and implementation summary for LSA 12-06.

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# Table 26-2FSS Design Summary for LSA 12-06

Scan Coverage		100% exposed soil and rock		
		40.9 pCi/g total Uranium (based on a 10,000		
Scan MDC	-	n background); 0.87 pCi/g Th-232; 1.21		
		i/g Ra-226*		
Investigation Action Level (IAL)	4,0	00 net cpm **		
Systematic Sampling Locations:		· · · · · · · · · · · · · · · · · · ·		
Depth	Number of Sample	Comments		
0-15 cm (Surface)	8	These samples will be taken on a		
15 cm – 1.5 m (Root)	8	- random-start systematic grid.		
> 1.5m (Excavation)	8	initiation start systematic gra.		
<b>Biased Survey/Sampling Location</b>	s:	·		
Sidewall Sampling Locations:				
A minimum of one (1) discretionary of "sidewall": sidewall candidates				
A minimum of one (1) discretionary of "sidewall": sidewall candidates least 12" in height.	for sampling must be ve detector; with Used	collected based on the following definition rtical or near vertical (> 45° angle) and a for GWS and to obtain static count rates a l measurement locations.		
A minimum of one (1) discretionary of "sidewall": sidewall candidates least 12" in height. Instrumentation: Ludlum 2221 with 44-10 (2x2 Naf) collimation for investigations *Values based on information prov Scanning Minimum Detectable Con for total Uranium reflects a conserv	for sampling must be very detector; with Used biased ided in HDP-TBD-FSS- centrations (MDC) for h vative assumption of 4%	rtical or near vertical (> 45° angle) and a for GWS and to obtain static count rates a		

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# 27.0 FINAL STATUS SURVEY IMPLEMENTATION LSA 12-06

FSS was performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.

# 27.1 Gamma Walkover Survey

## 27.1.1 Instrumentation

The selected instrumentation to perform the GWS in LSA 12-06 was a 2" x 2" NaI detector in combination with a Ludlum 2221 rate meter. Each NaI instrumentation set was interfaced with a Trimble DGPS (Digital Global Positioning System) and handheld data logger.

Prior to the first field use of the GWS instrumentation, initial set-ups were performed. Also, daily pre- and post-use source checks were performed for each day that GWS was performed within the SU. Initial set-ups, daily source checks, and control charting were performed according to the requirements of HDP-PR-HP-416, *Operation of the Ludlum 2221 for Final Status Survey*.

## 27.1.2 GWS Performance

All GWS measurements on the excavation floor and sidewalls collected with the NaI detector(s) were connected to a Trimble DGPS and with a hand-held data logger. The logging frequency in the survey unit was 1 GWS measurement per second. Each gross gamma measurement is correlated to a set of coordinates based on the Missouri East State Plane, NAD 1983.

The GWS requirements involved moving the NaI detector in a side-to-side fashion no faster than 1 foot per second while holding the probe as close as possible to the excavation surface (nominally 1", but not to exceed 3"). At the same time, the technician was required to slowly advance, causing the detector to trace out a serpentine path over the excavation surface.

FSS Technicians performing GWS in LSA 12-06 used the 4,000 ncpm IAL as a field guide to know when to slow or pause the GWS for more deliberate investigation. If during the GWS, audible count rates noticeably increase above the general area average (i.e., > minimum detectable count rate), FSS Technicians were required to pause momentarily and observe count rates. If sustained count rates approached the IAL, further focused investigation was conducted within the locally elevated area.

To use the IAL effectively, FSS Technicians first determined the local background count rate before starting the GWS. Although the ambient gamma level may vary across the SU due to the geometry and relative distance from contaminated materials in nearby remedial excavations, the average background rate (measured at waist level) within the LSA ranged between 10,000 and 11,000 gcpm. Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 14,000 to 15,000 gcpm, FSS Technicians slowed or paused the GWS for more careful investigation of the small areas of elevated activity before deciding if "flagging" a point for potential biased sampling was warranted.

Hard to reach areas, and non-typical areas were surveyed manually as necessary in order to assess the potential for an area of elevated residual activity over 100% of the exposed ground surface.

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After the GWS survey was complete, the GPS/GWS data was reviewed by Radiological Engineering and the Health Physics Technician performing the survey to determine if possible areas of elevated residual activity remained within the SU that required biased sample investigation. Areas that were flagged by the HP Technician were considered, as well as a statistical evaluation of the GWS data set. The statistical evaluation determined the mean count rate and standard deviation associated with the GWS and then could be used to identify any areas that exceeded 3 standard deviations above the mean. The number of biased samples to be collected and the locations are based on flagged locations exceeding the IAL, the statistical evaluation of the GWS data set, and the professional judgment of Radiological Engineering.

## 27.2 Soil Sampling

## 27.2.1 Systematic Soil Sampling Summary

Table 27-1 provides a summary of systematic sampling by stratum for LSA 12-06.

		Systematic Sum	Pring Summer J	by Stratam 10		
ſ		SU Area,		Systematic		
	LSA	planar (m <sup>2</sup> )	Surface	Root	Deep (Excavation)	QC
	12-06	1,994	8	8	8*	2

 Table 27-1

 Systematic Sampling Summary by Stratum for LSA 12-06

\*Excavation samples were collected and archived, analysis only required if a overlying Root sample exceeds a 0.5 SOF

# 27.2.2 Systematic Sampling LSA 12-06

Within LSA 12-06, there were 8 systematic locations in which the surface stratum (0 - 15 cm) was sampled in the SU. The underlying root stratum was sampled at all 8 locations. Excavation stratum samples were collected and archived, but were not required to be analyzed since no root stratum sample exceeded a 0.5 Uniform SOF.

Given a planar area of  $1,994 \text{ m}^2$  for LSA 12-06 and an eight - point systematic triangular grid, the point-to-point distance within each row was 16.9 m with spacing of 14.6 m between each of the parallel grid rows within the SU.

While there were eight (8) systematic locations on the LSA 12-06 sampling grid, a total of eighteen (18) samples were collected and analyzed at these locations, including:

- Eight (8) samples collected and analyzed within the surface stratum
- Eight (8) samples collected and analyzed within the root stratum
- Zero (0) samples analyzed within the excavation, or "deep" stratum
- Two (2) QC field replicate

Figure 27-1 presents the map of the eight systematic sample locations which were sampled within LSA 12-06. The inset table notes the location coordinates (Missouri East, NAD 1983) and collection intervals for each systematic location.

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	LSA 12-06 Syst	Figure 27-1 tematic Soil Sample Locations
Hematita	L12-06-04	•••
Sample II L12-06-01-P-S L12-06-02-P-R L12-06-03-P-E L12-06-04-P-S L12-06-05-P-R L12-06-05-P-R L12-06-06-P-E L12-06-07-P-S L12-06-10-P-S L12-06-11-P-R L12-06-12-P-E L12-06-13-P-S L12-06-13-P-S L12-06-14-P-R L12-06-15-P-E L12-06-14-P-R L12-06-14-P-R L12-06-17-P-R L12-06-17-P-R	S-00         6         59         865643         827823         L12-4           S-00         59         65         865643         827823         L12-4           S-00         59         65         865643         827823         L12-4           S-00         0         6         865595         827795         S200         59         65         865595         827795           S-00         6         59         865595         827795         S200         59         65         865595         827851           S-00         6         59         865595         827823         S27851         S200         6         59         865595         827823         S200         6         59         865547         827823         S200         6         59         865547         827823         S200         S20         6         59         865547         827878         S200         6         59         865547         827878         S200         59         65         865547         827878         S200         59         65         865547         827878         S200         59         65         865547         827878         S200         S200         6         5	LSA 12-06 1994 m <sup>2</sup> Planar Area L12-06-13-P-S-Q-00 L12-06-14-P-R-S-00 L12-06-15-P-E-S-00 L12-06-13-P-S-S-00 L12-06-19-P-S-S-00 L12-06-19-P-S-S-00 L12-06-19-P-S-S-00 L12-06-20-P-R-S-00 L12-06-21-P-E-S-00 L12-06-21-P-E-S-00 L12-06-22-P-S-S-00 L12-06-23-P-R-S-00 L12-06-24-P-E-S-00 L12-06-24-P-E-S-00
L12-06-19-P-5 L12-06-20-P-R L12-06-21-P-E L12-06-22-P-S L12-06-23-P-R L12-06-23-P-R L12-06-07-P-S L12-06-07-P-S L12-06-13-P-S	5-00         0         6         865499         827961           5-00         6         59         865499         827961           5-00         59         65         865499         827961           5-00         59         65         865499         827961           5-00         0         6         865451         827934           5-00         6         59         865451         827934           5-00         59         65         865451         827934           6-00         59         65         865451         827934           6-00         0         6         865595         827851	0 15 30 60 90 120 Feet

пспанс	FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12, Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)			
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Figure 27-2 below presents a tabular listing of all FSS samples collected within LSA 12-06 with associated IDs, sample types, collection intervals, coordinates, and notes.

# Figure 27-2 FSS Sample Locations and Coordinates for LSA 12-06

Hematite		Procedure	: HDP-PR-FSS	-701, Final Stat	us Survey Plan	Development			
Decommission Project	ing				Revision: 10	Appendix P-4, Page 1 of			
APPENDIX P-4 FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES									
Survey Area:	LSA	12	_	Description:		Laydown Are	ea, Plant Soils SEA		
Survey Unit:	0	6		Description:		Class 1 Laydown	Land Area in "Area 13"		
Survey Type:	FS	S	-	Classificatio			Class 1		
			-						
Measurement or Sample ID	Surface or CSM	Туре	StartEndNorthing**Elevation*Elevation*(Y Axis)			Easting** (X Axis)	Remarks / Notes		
L12-06-01-P-S-S-00	Uniform	S	432.7	432.2	865643	827823	Surface 6-inch grab		
L12-06-02-P-R-S-00	Uniform	S	432.2	427.8	865643	827823	Root 59-inch composite		
L12-06-04-P-S-S-00	Uniform	S	432.7	432.3	865595	827795	Surface 6-inch grab		
L12-06-05-P-R-S-00	Uniform	S	432.3	427.8	865595	827795	Root 59-inch composite		
L12-06-07-P-S-S-00	Uniform	S	431.7	431.2	865595	827851	Surface 6-inch grab		
L12-06-08-P-R-S-00	Uniform	S	431.2	426.8	865595	827851	Root 59-inch composite		
L12-06-10-P-S-S-00	Uniform	S	431.8	431.3	865547	827823	Surface 6-inch grab		
L12-06-11-P-R-S-00	Uniform	S	431.3	426.9	865547	827823	Root 59-inch composite		
L12-06-13-P-S-S-00	Uniform	S	432.3	431.8	865547	827878	Surface 6-inch grab		
L12-06-14-P-R-S-00	Uniform	S	431.8	427.4	865547	827878	Root 59-inch composite		
L12-06-16-P-S-S-00	Uniform	S	430.3	429.8	865499	827906	Surface 6-inch grab		
L12-06-17-P-R-S-00	Uniform	S	429.8	425.4	865499	827906	Root 59-inch composite		
L12-06-19-P-S-S-00	Uniform	S	428.9	428.4	865499	827961	Surface 6-inch grab		
L12-06-20-P-R-S-00	Uniform	S	428.4	424.0	865499	827961	Root 59-inch composite		
L12-06-22-P-S-S-00	Uniform	S	430.4	429.9	865451	827934	Surface 6-inch grab		
L12-06-23-P-R-S-00	Uniform	S	429.9	425.4	865451	827934	Root 59-inch composite		
L12-06-07-P-S-Q-00	Uniform	Q	431.7	431.2	865595	827851	Surface 6-inch grab		
L12-06-13-P-S-Q-00	Uniform	0	432.3	431.8	865547	827878	Surface 6-inch grab		
	Uniform	×	100.0	101.0	000011	02/0/0	Sandee o men grub		

Green shaded samples are the samples at each sample location, for use in WRS Test.

\*Elevations are in feet above mean sea level.

\*\* Missouri - East State Plane Coordinates [North American Datum (NAD) 1983]

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R

CSM: Three-Layer (Surface-Root-Excavation) or Uniform DCGLs used

Type: Systematic = S, Biased = B; QC =Q; Investigation = I

Quality Record

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#### 27.3 Biased Soil Sampling

As discussed in FSSFR Volume 3, Chapter 1, Section 6.1.3, there are three key methods for identifying areas for biased soil sampling, the IAL, the Z-score of the FSS GWS, and the professional judgment of the HP Staff. For LSA 12-06 one (1) biased sample location was selected within the SU based on the evaluation of the GWS survey data and HP Technician professional judgment. This biased location represented the maximum GWS measurement encountered within the SU. Biased samples are collected at the prescribed location to a depth of 6 inches below the exposed ground surface.

#### 27.4 Judgmental/Sidewall Sampling for Tc-99

As an un-excavated SU, no Tc-99 sidewall sampling was necessary for LSA 12-06.

#### 27.5 Quality Control Soil Sampling

Two QC field duplicate sample point were randomly selected and collected at systematic locations L12-06-07 and L12-06-13 for LSA 12-06.

#### 28.0 FINAL STATUS SURVEY RESULTS LSA 12-06

#### 28.1 Gamma Walkover Survey

Post-processed GPS coordinate data is accurate to within  $\pm 0.1$  m for the handheld GPS models used during the GWS. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same GPS location during the walkover, the most elevated radiological measurements are plotted "on top" (e.g. if any sidewalls featured more elevated readings than the floor directly below, the sidewall radiological measurements would overlie the lower floor readings).

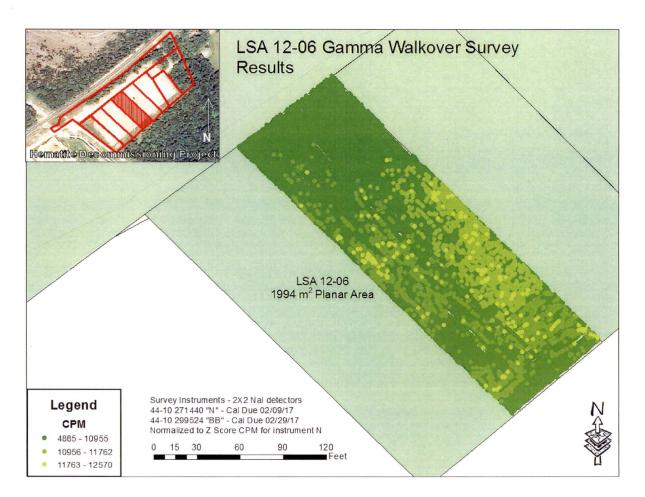
GWS measurements were collected in LSA 12-06 between May 6, 2016, and May 15, 2016.

#### 28.1.1 GWS Results for LSA 12-06

For LSA 12-06, GWS count rates ranged between 4,885 gcpm and 12,451 gcpm, with a mean count rate of 10,148 gcpm. The median count rate was 8,713 gcpm and the standard deviation was 807 cpm. Figure 28-1 below presents a map of the complete GWS data set.

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Figure 28-1 Colorimetric GWS Plot for LSA 12-06

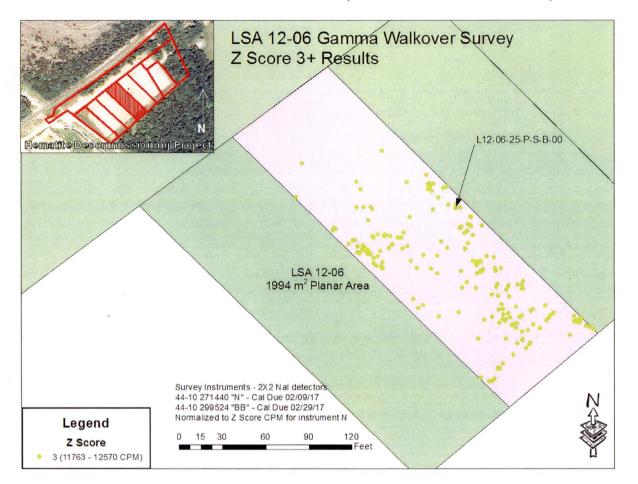


An evaluation of the entire GWS data set was performed to evaluate those small areas of elevated activity which exceeded three (3) standard deviations above the GWS mean measurement, (i.e., "+3 Z-score"). One locations, L12-06-25, was selected for biased sample collection. These biased locations represented the maximum GWS measurements encountered within the SU of 15,852 gcpm.

Figure 28-2 below presents a map of the +3 Z-score GWS measurements within LSA 12-06, including the selected biased sampling locations (ID: L12-06-25-P-S-B-00).

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Figure 28-2 Colorimetric GWS Plot for LSA 12-06 (Measurements > Z-score of 3)



All GWS data collected in LSA 12-06 was datalogged and post-processed in Graphical Information Software (GIS).

#### 28.1.2 GWS Coverage Results LSA 12-06

FSSFR Volume 3, Chapter 1, Section 6.1.4, *Exposed Surfaces versus Accessible Surfaces*, provides a discussion and the criteria for evaluating the GWS coverage of a SU during FSS. Although 100% of accessible areas underwent GWS, the post survey processing of the GPS data indicated that the GWS covered 99.0% of the SU (see Table 28-1). As the evaluation indicates that the GPS coverage exceeded 95% with no readings approaching or exceeding the IAL of 4,000 net cpm in the vicinity of any apparent GPS coverage gaps, the GWS coverage for the SU has been evaluated to meet the intent of the "100% GWS coverage" requirement.

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# Table 28-1GWS Gap Analysis LSA 10-04

	Total SU	GWS Gap	Gap	GWS	MARSSIM
	Pixels	Pixels	Percentage	Coverage	Class
LSA 12-06	154,817	1,550	1.0	99.0	1

#### 28.2 Soil Sample Results LSA 12-06

Appendix D presents the analytical results and associated statistics for all FSS samples collected within LSA 12-06.

#### 28.2.1 Surface Soil Sample Results LSA 12-06

There were eight systematic samples collected within the surface stratum (0 - 15 cm) of LSA 12-06. Additionally there were two QC samples and one biased sample collected from the topmost layer of soil. The maximum Uniform SOF result for the surface samples was 0.21.

#### 28.2.2 Subsurface Soil Sample Results LSA 12-06

There were eight systematic locations within LSA 12-06 where root stratum composite sampling was necessary. The root stratum zone is between 0.15 and 1.50 m below final grade surface. At each of the eight root stratum composite sampling locations, the top six inches (1.50 - 1.65 m below final grade surface) of the underlying excavation stratum was also collected and archived, however these excavation samples were not required to be analyzed as no overlying root stratum sample exceeded a 0.5 SOF. The maximum SOF result of the subsurface samples collected in LSA 12-06 was 0.24.

#### 28.2.3 WRS Evaluation

Per Step 7.8.3 of HDP-PR-FSS-721 *Final Status Survey Data Evaluation*, the Wilcoxon Rank Sum (WRS) statistical test was not required for LSA 12-06 since the difference between the maximum SU data set gross SOF and the minimum background area SOF was less than one using the Uniform Stratum criteria. However, for illustrative purposes, the WRS evaluation was still performed for LSA 12-06. All systematically collected samples regardless of depth are used to perform the WRS Test, however biased and QC sample results are not utilized in the WRS Test. The 16 systematically collected samples in LSA 12-06 were ranked against the adjusted activity concentrations of the 32 samples collected within the Background Reference Area. The SU passed the WRS Test since the ranked sum of the reference area ranks, or test statistic  $W_{R}$ , (1040) was greater than the critical value (860) for the test. As such, the null hypothesis that the SU average concentration is greater than the DCGL<sub>W</sub> was rejected. The WRS evaluation is also included in Appendix D.

#### 28.2.4 Graphical Data Review LSA 12-06

Table 28-2 below presents summary results for the all systematically collected samples (includes surface, and root, but not biased or QC samples) collected within LSA 12-06, and the associated

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SOF when compared to the Uniform Stratum  $DCGL_{ws}$ . The arithmetic average concentration resulted in a SOF of 0.11.

Statistic	Ra-226 DCGL = 1.9 BKG = 1.07 (pCi/g)	Tc-99 DCGL = 25.1 (pCi/g)	Th-232 DCGL = 2.0 BKG = 1.0 (pCi/g)	U-234 DCGL=195.4 (pCi/g)	U-235 DCGL=51.6 (pCi/g)	U-238 DCGL=168.8 (pCi/g)	Sample SOF (Uniform DCGL)
Average	0.041	0.556	0.083	2.915	0.118	1.209	0.11
Minimum	0.00 ( <bkg)< td=""><td>0.00 (NEG)</td><td>0.00 (<bkg)< td=""><td>0.705</td><td>-0.128</td><td>0.648</td><td>0.02</td></bkg)<></td></bkg)<>	0.00 (NEG)	0.00 ( <bkg)< td=""><td>0.705</td><td>-0.128</td><td>0.648</td><td>0.02</td></bkg)<>	0.705	-0.128	0.648	0.02
Maximum	0.270	3.130	0.310	8.553	0.472	1.960	0.24

# Table 28-2 LSA 12-06 FSS Sample Data Summary and Calculated SOF Values (Systematic)

Notes:

1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.

2. Average SOF for data set calculated using average radionuclide concentrations.

3. U-234 values are inferred from the U-235/U-238 ratio.

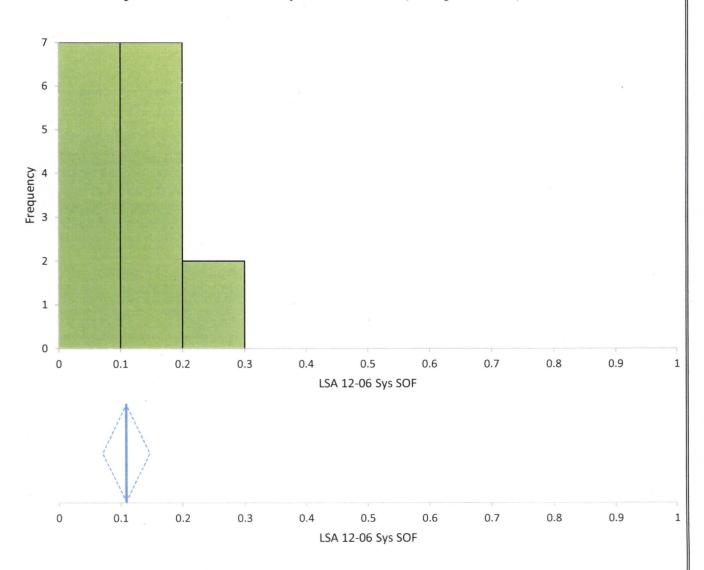
Section 8.2.2.2 of MARSSIM recommends a graphical review of FSS analytical data, to include at a minimum, a posting plot and a histogram. A frequency plot, or histogram, is a useful tool for examining the general shape of a data distribution. This plot is a bar chart of the number of data points within a certain range of values. The frequency plot will reveal any obvious departures from symmetry, such as skewness or bimodality (two peaks), in the data distribution for the survey unit. The presence of two peaks in the survey unit frequency plot may indicate the existence of isolated areas of residual radioactivity.

Figure 28-3 presents the overall statistical metrics for the SOF parameter for the 16 systematically collected samples from LSA 12-06. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 12-06. The middle graph presents the mean SOF (0.11 as indicated by the blue vertical line) of the sample population and the 95% confidence interval of the mean SOF represented by the blue diamond which is 0.07 to 0.15. The 97.87% confidence interval based on the median (also 0.11) of the sample results is 0.05 to 0.19. The bottom two charts present the various statistical metrics of the LSA 12-06 SOF data set, including the mean, median, standard deviation, minimum, maximum, confidence intervals, etc.

Figure 28-3 exhibits no unusual symmetry or bimodality concerns for the LSA 12-06 data associated with the systematically collected measurement locations.

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Figure 28-3 Graphic Statistical Summary for LSA 12-06 (SOF parameter)



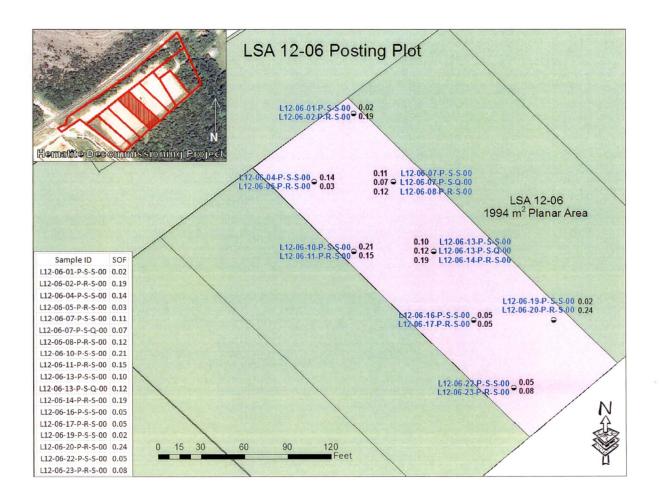
N 16

	Mean	95%	6 CI	Mean SE	SD	Variance	Skewness	Kurtosis
LSA 12-06 Sys SOF	0.11	0.07	to 0.15	0.018	0.07	0.01	0.4	-1.17
	Minimum	1st quartile	Median	97.87	% CI .	3rd quartile	Maximum	IQR
LSA 12-06 Sys SOF	0.02	0.05	0.11	0.05	to 0.19	0.17	0.2	0.13

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A posting plot is simply a map of the survey unit with the data values (in this case the SOF values for each systematically collected sample) entered at the measurement locations. This potentially reveals heterogeneities in the data – especially possible patches of elevated residual radioactivity. The posting plot for LSA 12-06 is presented below in Figure 28-4. Figure 28-4 shows no unusual patterns in the data.

#### Figure 28-4 Posting Plot for LSA 12-06 Systematic Measurement Locations



Appendix D to this report presents the complete analytical data set (in Microsoft Excel format) used to derive the summary statistics presented in Table 28-2, Figure 28-3, and Figure 28-4 above. A summary of the analytical data is presented in Table 28-3 below. Appendix R to this report presents the TestAmerica Analytical Laboratory soil sample reports.

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Table 28-3

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												Fi	nal S	tatus	Survey	Analy	vtical	Data:	LSA 1	2-06													
						,																											
															ToetAr	nerica An	alutica	Doculto															
	(#t)	Ő			1000	-									TESLAI	nerica Ali	arytica	Results		1.1.1.1.1	18-18-1 19-19-19-19-19-19-19-19-19-19-19-19-19-1	19562									G. States		
9	pth	Bias			Ra-2	226					Гс-99					Th-2	232			1	nferred	U-234			U-23	35			U-2	38		Enr.	SOF
Sample ID	Sample Depth (ft)	Type (Systematic, Bi	Result	Uncertainty	MDC	Qualifier	Net Result*	Corrected Result	Result	Corrected Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Net Result**	Corrected Result	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Enrichment (%)	SOF
L12-06-01-P-S-S-00	0.00	S	0.933	0.145	0.0758	N/A	-0.137	0.000	0.159	0.159	0.163	0.231	U	0.905	0.149	0.104	N/A	-0.095	0.000	1.489	NA	NA	NA	0.0775	0.179	0.366	U	0.989	0.294	0.73	N/A	1.3	0.02
L12-06-02-P-R-S-00	0.50	S	1.15	0.161	0.0747	N/A	0.080	0.080	0.0159	0.016	0.053	0.227	U	1.28	0.192	0.116	N/A	0.280	0.280	1.050	NA	NA	NA	-0.123	0.123	0.534	U	1.05	0.52	0.805	N/A	0.7	0.19
L12-06-04-P-S-S-00	0.00	S	1.2	0.174	0.0624	N/A	0.130	0.130	1	1.000	0.149	0.217	N/A	0.479	0.197	0.189	N/A	-0.521	0.000	3.770	NA	NA	NA	0.202	0.136	0.188	N/A	1.8	0.801	0.95	N/A	1.8	0.14
L12-06-05-P-R-S-00	0.50	S	1.03	0.148	0.0691	N/A	-0.040	0.000	0.0071	0.007	0.064	0.237	U	1.02	0.166	0.106	N/A	0.020	0.020	1.524	NA	NA	NA	0.0793	0.2	0.333	U	0.941	0.334	0.836	N/A	1.3	0.03
L12-06-07-P-S-S-00	0.00	S	1.02	0.157	0.077	N/A	-0.050	0.000	1.01	1.010	0.202	0.231	N/A	1.07	0.197	0.0899	N/A	0.070	0.070	4.254	NA	NA	NA	0.234	0.128	0.196	N/A	1.17	0.538	0.819	N/A	3.1	0.11
L12-06-08-P-R-S-00	0.50	S	1.08	0.151	0.0646	N/A	0.010	0.010	-0.0232	0.000	0.133	0.232	U	1.18	0.175	0.0708	N/A	0.180	0.180	2.757	NA	NA	NA	0.151	0.109	0.156	U	0.852	0.28	0.761	N/A	2.7	0.12
L12-06-10-P-S-S-00	0.00	S	0.899	0.138	0.07	N/A	-0.171	0.000	3.13	3.130	0.345	0.22	N/A	1.04	0.162	0.0768	N/A	0.040	0.040	8.553	NA	NA	NA	0.472	0.155	0.204	N/A	1.96	0.377	0.762	N/A	3.7	0.21
L12-06-11-P-R-S-00	0.50	S	1	0.147	0.0558	N/A	-0.070	0.000	2.57	2.570	0.375	0.232	N/A	1.07	0.187	0.0736	N/A	0.070	0.070	1.603		NA	NA	0.0818	0.139	0.59	U	1.21	0.506	0.756	N/A	1.1	0.15
L12-06-13-P-S-S-00	0.00	S	1.1	0.144	0.0581	N/A	0.030	0.030	0.273	0.273	0.168	0.231	N/A	1.09	0.159	0.113	N/A	0.090	0.090	4.298	NA	NA	NA	0.237	0.176	0.216	N/A	0.648	0.285	0.796	U	5.4	0.10
L12-06-14-P-R-S-00	0.50	S	1.34	0.197	0.0741	N/A	0.270	0.270	0.0464	0.046	0.059	0.232	U	1.05	0.182	0.217	N/A	0.050	0.050	1.440	NA	NA	NA	0.0687	0.186	0.654	U	1.51	0.879	1.07	N/A	0.7	0.19
L12-06-16-P-S-S-00	0.00	S	0.95	0.139	0.0641	N/A	-0.120	0.000	0.185	0.185	0.099	0.223	U	0.965	0.168	0.0853	N/A	-0.035	0.000	5.268	NA	NA	NA	0.291	0.176	0.207	N/A	0.979	0.314	0.856	N/A	4.5	0.05
L12-06-17-P-R-S-00	0.50	S	1.04	0.152	0.0703	N/A	-0.030	0.000	-0.019	0.000	0.051	0.238	U	1.08	0.163	0.122	N/A	0.080	0.080	0.705		NA	NA	-0.052	0.105	0.355	U	0.705	0.287	0.793	U	0.7	0.05
L12-06-19-P-S-S-00	0.00	S	0.797	0.135	0.0726	N/A	-0.273		0.21	0.210	0.2	0.236	U	1.01	0.165	0.115	N/A	0.010	0.010	1.270		NA	NA	-0.128	0.321	0.575	U	1.27	0.536	0.801	N/A	0.7	0.02
L12-06-20-P-R-S-00	0.50	S	1.2	0.158	0.0612	N/A		0.130	-0.055	0.000	0.041	0.229	U	1.31	0.214	0.115	N/A	0.310	0.310	1.290	NA	NA	NA	-0.014	0.198	0.517	U	1.29	0.538	0.815	N/A	0.7	0.24
L12-06-22-P-S-S-00	0.00	S	0.979	0.151	0.0701	N/A		0.000	0.215	0.215	0.097	0.233	U	0.917	0.157	0.0879	N/A	-0.083	0.000	5.977	NA	NA	NA	0.329	0.166	0.198	N/A	1.58	0.749	0.909	N/A	3.2	0.05
L12-06-23-P-R-S-00	0.50	S	1.04	0.17	0.089	N/A	-0.030		0.0736	0.074	0.061	0.237	U	1.12	0.183	0.112	N/A	0.120	0.120	1.390		NA	NA	-0.019	0.048	0.36	U	1.39	0.619	0.94	N/A	0.7	0.08
L12-06-07-P-S-Q-00	0.00	Q	1.06	0.142	0.0544	N/A	-0.010		0.144	0.144	0.048	0.232	U	1.04	0.165	0.123	N/A	0.040	0.040	5.438		NA	NA	0.3	0.144	0.177	-	1.27	0.499	0.749		3.6	0.07
L12-06-13-P-S-Q-00	0.00	Q	0.772	0.154	0.162	N/A		0.000	0.333	0.333	0.082	0.223	N/A	1.19	0.229	0.108	N/A	0.190	0.190	1.030	NA	NA	NA	-0.134	0.339	0.689	U	1.03	0.361	0.936	N/A	0.7	0.12
L12-06-25-P-S-B-00	0.00	В	1.950	0.254	0.092	N/A	0.880	0.880	0.319	0.319	0.068	0.192	N/A	1.080	0.171	0.108	N/A	0.080	0.080	5.100	NA	NA	NA	0.280	0.144	0.194	N/A	1.490	0.570	0.842	N/A	2.9	0.56
Systematic Min	nimum				0.00	00				(	0.000				_	0.00	00				0.7	05			-0.12	28			0.64	18		2.1	0.02
Systematic Max	ximum	and a			0.27	70					3.130					0.31	10				8.5	53			0.47	72			1.96	60		e t (%)	0.24
Systematic N	lean				0.04	41				(	0.556					0.08	83				2.9	15			0.11	18			1.20	)9		erage ment	0.11
Systematic Me	edian	24.2			0.00	00				(	0.172					0.06	60				1.5	64			0.08	31			1.19	90		Aver	0.11
Systematic Standard	d Deviati	on			0.07	76				(	0.956					0.09	97				2.2	37			0.16	69			0.37	72		Eni	0.07
A CONTRACTOR	182.2	100	With in	growth, u	se Ra226	6 bkg =	1.3.2.1.	1.07	Sale Sale				1000	Th232	bkg =	1.0			S. A. S.	0					11. 11		1	The second	23.24	2. 1.			

NOTES:

Gross results in units of pCi/g.

\* Background with ingrowth (1.07 pCi/g) subtracted from gross result.

\*\*Background (1.0 pCi/g) subtracted from gross result.

U Qualifier: Result is less than the sample detection limit.

All uncertainty values are reported at the 2-sigma confidence level.

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#### 28.2.5 Biased Soil Sample Result LSA 12-06

One (1) biased sample was collected from LSA 12-06. The sample collected at location L12-06-25 represented the maximum GWS measurement (12,541 gcpm) within the SU, and had a result of 0.56 Uniform SOF.

#### 28.2.6 Quality Control Soil Sample Result LSA 12-06

Two QC field duplicate sample points were randomly selected for LSA 12-06 which were collected at systematic locations L12-06-07 and L12-06-13.

For the 17 samples (i.e., 16 systematic + 1 biased) collected within LSA 12-06, two field duplicate samples were collected. This frequency equates to 11.8%, (i.e. 2/17). Form HDP-PR-FSS-703-1 documents that the duplicate sample result comparison with the partner's sample results that all comparison criteria were less than the calculated warning limits (see Figure 28-5 below).

The statistical assessment of the Laboratory QC sample results indicated that one field duplicate sample exceeded the calculated Warning Limit, but was less than the calculated Control Limit. The one sample result that exceeded the Warning Limit was sample L12-06-13-P-S-S-00 for Ra-226. In accordance with procedure HDP-PR-FSS-703, when an exceedance occurs an investigation is performed to determine if corrective actions were necessary. The investigation determined that for Ra-226 the calculated statistic (0.328) only slightly exceeded the calculated Warning Limit (0.269). Also, considering the low activity and the errors associated with the sample results, the Ra-226 activity of both samples were relatively close. Based upon the investigation of the exceedance and the results of previous Quality Assurance audits of the overall performance of the laboratory, no corrective actions were determined to be necessary.

Decommissionin Project	Revisio	on: 1										Page 107 of
	Form H	DP-PR-FS	S-703-1 F	ield D	Figure 28- uplicate Sa		ssessment L	SA 12-0	6 (1 of 2	)		
Hematite	Procedure: HDP-PR	-FSS-703, Fin	al Status Sur	vey Qua	ality Control							
Decommissioning Project								Revisi	on: 2		Page I	of 1
			FIE		FORM HDP-I PLICATE SA		03-1 SSESSMENT	determinante la construction de la				
Survey Unit No.:	LSA 12-06		-		Survey Unit D	escription:	Class I Laydow	n Land Are	a in "Area	3"		
	Field Duplicate		Sample (p	oCi/g)	Field Duplica (pCi/	te Sample	Average Activity $(\bar{\chi})$	Nuclide DCGL		Warning	Control	Statistic Exceeds Limit?
Sample ID	Sample ID	Radionuclide			Activity (x <sub>i</sub> )	MDC	(pCi/g)	(pCi/g)	Statistic <sup>2</sup>	Limit	Limit	(Y/N)
L12-06-07-P-S-S-00	L12-06-07-P-S-Q-00	Ra-226	1.02	0.077	1.06	0.0544	1.040	1.9	0.04	0.269	0.403	N
L12-06-07-P-S-S-00	L12-06-07-P-S-Q-00	Tc-99	1.01	0.231	0.144	0.232	0.577	25.1	NA	3.552	5.321	NA
L12-06-07-P-S-S-00	L12-06-07-P-S-Q-00	Th-232	1.07	0.0899	1.04	0.123	1.055	2.0	0.030	0.283	0.424	N
L12-06-07-P-S-S-00	L12-06-07-P-S-Q-00	U-234 <sup>1</sup>	4.254	N/A	5.438	N/A	4.846	195.4	1.184	27.649	41.425	N
L12-06-07-P-S-S-00 L12-06-07-P-S-S-00	L12-06-07-P-S-Q-00 L12-06-07-P-S-Q-00	U-235 U-238	0.234	0.196	0.3	0.177	0.267	51.6 168.8	0.066	7.301 23.885	10.939 35.786	N N
Comments: 1. U-234 is inferred, n 2. Duplicate assessme	to MDC available. Int is not necessary if the	result of either	sample is < 1	MDC.	-							
Performed by: 7	homas Jurdy	1 Mire	la-				Reviewed by:	W. Clan	K.Erry,	Iw.	he	n
Date:	11-23-16						Date: ///	23/14				
Quality Record						- 						

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	Form H	DP-PR-FS	S-703-1 F	ield D	Figure 28 uplicate Sa		ssessment I	.SA 12-0	6 (2 of 2	2)		
Hematite	Procedure: HDP-PR	FSS-703, Fin	al Status Sur	vey Qua	lity Control			-0.0				
Decommissioning Project								Revisi	on: 2		Page 1	of 1
<u></u>			FIE		'ORM HDP-I PLICATE SA		)3-1 SSESSMENT	<u>,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,</u>		<u> </u>	•••	
Survey Unit No.:	LSA 12-06	. <u> </u>			Survey Unit D	Description:	Class I Laydow	n Land Are	a in "Area	13"		
	Field Duplicate		Sample (p	-	Field Duplica (pCi/	ite Sample g)	Average Activity $(\bar{\chi})$	Nuclide DCGL		Warning	Control	Statistic Exceeds Limit?
Sample ID	Sample ID	Radionuclide			Activity (x <sub>i</sub> )	MDC	(pCi/g)	(pCi/g)	Statistic <sup>2</sup>	Limit	Limit	(Y/N)
L12-06-13-P-S-S-00	L12-06-13-P-S-Q-00	Ra-226	1.1	0.0581	0.772	0.162	0.936	1.9	0.328	0.269	0.403	Y
L12-06-13-P-S-S-00 L12-06-13-P-S-S-00	L12-06-13-P-S-Q-00 L12-06-13-P-S-Q-00	Tc-99 Th-232	0.273	0.231	0.333	0.223	0.303	25.1	0.06	3.552 0.283	5.321 0.424	<u>N</u> N
	L12-06-13-P-S-Q-00	U-234 <sup>1</sup>	4.298	N/A			2.664	195.4	3.268	27.649	i — — — —	<b>├─────</b> ╢
L12-06-13-P-S-S-00 L12-06-13-P-S-S-00	L12-06-13-P-S-Q-00	U-235	0.237	0.216	-0.134	N/A 0.689	0.052	51.6	3.208 NA	7.301	41.425	N NA
L12-06-13-P-S-S-00	L12-06-13-P-S-Q-00	U-238	0.648	0.796	1.03	0.936	0.839	168.8	NA	23.885	35.786	NA
	nt is not necessary if the	,	-							· ) , , ,	1 .	
Performed by:	Thomas Yar	ey/r	hn !	n_			Reviewed by:	W.U.	ark Exc	s/w	Ch	en
Date:	11-23-16	<u> </u>					Date: 1/2	3/16				
Quality Record				`								

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# 28.3 Tc-99 Hot Spot Assessment LSA 12-06

There is no historical sampling data available for this area since it was always considered a nonimpacted area prior to the storage of potential reuse soils within the LSA. As a previously unimpacted area there is no history of a Tc-99 sample result ever exceeding the Tc-99 Uniform  $DCGL_w$ , as only potential reuse soil was placed within the LSA. The highest Tc-99 sample result collected from both Final RASS and FSS was 3.13 pCi/g. Therefore there is no concern for a potential Tc-99 hot spot exceeding the  $DCGL_w$  of 25.1, and there is no reason to perform a Tc-99 hot spot assessment.

#### 29.0 ALARA EVALUATION LSA 12-06

All samples collected within LSA 12-06 were evaluated against the Uniform Stratum DCGL<sub>w</sub>. For LSA 12-06 no sample result exceeded a SOF of 1.0. The average SOF result, based on all systematically collected samples, was 0.11 for LSA 12-06. The average SOF equates to residual activity contributions from the survey unit area of 2.75 mrem/yr for LSA 12-06. Groundwater Monitoring Well data provided in FSSFR Volume 6, Chapters 2 and 3 {ML16287A528} and Chapter 4 {ML16342B552}, indicate that the groundwater dose contribution will be a fraction of the MCLs. Nevertheless, a maximum groundwater contribution assumption of 4.0 mrem/yr based upon the EPA MCLs will be added to the total estimated dose for LSA 12-06. Adding these dose contributions together, the total estimated dose for LSA 12-06 is 6.75 mrem/yr.

Since the estimated Total Effective Dose Equivalent is well below the regulatory release criterion of 25 mrem/yr, the conclusion of the ALARA evaluation is that the FSS of LSA 12-06 was successful and that there would be no discernable benefit to the health and safety of the public in attempting to further reduce the results of FSS by performing remediation of LSA 12-06.

#### 30.0 FSS PLAN DEVIATIONS LSA 12-06

#### 30.1 Remedial Actions during FSS

There was no remedial action in LSA 12-06.

# **30.2** Adjustments to Scan MDC Calculations

Scan MDCs for LSA 12-06 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD- FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. The assumed LSA background count rate of 10,000 cpm was applied to determine the prospective Scan MDCs, and the actual mean count rate from the FSS survey was 10,148 cpm. Therefore the calculated Scan MDCs are appropriate, and no adjustments need to be made.

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# 31.0 DATA QUALITY ASSESSMENT

The DQO process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process are presented in Volume 3, Chapter 1, Section 4.0 of the FSSFR and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

#### 31.1 Data Quality Assessment for LSA 12-06

The Data Quality Assessment of the survey methodology, sampling and sample analysis results, and the Quality Control sampling and analysis results to ascertain the validity of the conclusion for LSA 12-06 (see Figure 31-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-416 (*Operation of the Ludlum 2221 for Final Status Survey*).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.
- The systematic samples that were collected (on a random-start triangular grid) and the gamma scan surveys that were conducted were performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.
- All samples sent for analysis at the approved offsite laboratory (TestAmerica) were tracked on a chain of custody form in accordance with HDP-PR-QA-006, *Chain of Custody*.
- Quality Control sample results were verified to meet the acceptance criteria as specified in HDP-PR-FSS-703, *Final Status Survey Quality Control*.
- LSA 12-06 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.
- The WRS Test is not necessary when the difference between the maximum survey unit data set measurement SOF and the minimum background area measurement SOF is less than or equal to one. For LSA 12-06, no individual gross SOF result in the FSS data set exceeded the SOF of the minimum background reference area measurement by more than one using the Uniform Stratum criteria. Therefore, the WRS Test was not required for LSA 12-06. However the WRS Test was still performed for illustrative purposes. Since the test statistic, WR (1040) exceeded the critical value (860), the FSS data set passed the WRS Test and the null hypothesis was rejected. The WRS Test worksheet is presented in Appendix D.
- A biased soil sample was collected from the location of the highest gamma count rate within the SU, and the result was a 0.56 Uniform SOF.
- The maximum SOF result for all surface samples within LSA 12-06 was 0.56

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(biased sample result). The maximum SOF result for all subsurface samples within LSA 12-06 was 0.24. The average SOF result for all systematically collected samples within LSA 12-06 was 0.11, with an upper 95% confidence level (UCL<sub>mean</sub> 0.95) of 0.15.

- No FSS sample result in LSA 12-06 exceeded a SOF of 1.0 as compared to the Uniform Stratum criteria, therefore an EMC or supplemental investigations was not required. For the same reason, no comparisons to the alternate "Three-Layer" multi-CSM (i.e. Surface, Root and Excavation) DCGLs were necessary.
- A retrospective sampling frequency evaluation was performed to determine if sufficient statistical power exists to reject the null hypothesis based on the total number (8) of systematic samples actually collected within LSA 12-06. The successful result of the retrospective power evaluation presented in Table 31-1 for LSA 12-06 indicates that the minimum number of samples required (8) for the WRS Test were equal to the number of sampling locations actually collected within LSA 12-06. The methodology used for the retrospective sampling frequency evaluation is similar to the prospective sample size determination performed during FSS Plan Development except that actual FSS sample results and statistics are used in the sample size verification. Specifically, the mean and standard deviation of the eight LSA surface samples (i.e., the WRS Test sample data set) are used to derive the relative shift for each LSA. Given the HDP Type I and Type II errors of 0.05 and 0.10, respectively, the calculated relative shift is then correlated to a minimum sample size number as provided in Table 5-1 of MARSSIM.

• HDP staff ensured that a visual inspection of the SU configuration and of the Isolation & Control measures were performed periodically, and confirmed that there were no instances of potential cross contamination from weather events until the FSS of all remaining areas at HDP were completed.

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# Table 31-1 **Retrospective Sample Size Verification for LSA 12-06**

Uniform DCG	L Criteria Evaluation
N/2 Val	ue Verification
Isotope(s)	SOF (Ra/Tc/Th/Iso U)
St. Dev.	0.07
DCGL <sub>SOF</sub>	1
LBGR (Mean)	0.11
Shift	0.89
Relative Shift (Δ/σ)	12.49
MARSSIM Table 5.1 (Pr)	1.000000
N	12
N + 20%	14.4
N/2	8
FSS N/2	8
Verification Check	SUFFICIENT MEASUREMENTS

"N/2" Corresponds to the number of survey unit measurement locations required for the WRS Test

MARS	SIM Table 5.1
Δ/σ	Pr
0.1	0.528182
0.2	0.556223
0.3	0.583985
0.4	0.611335
0.5	0.638143
0.6	0.664290
0.7	0.689665
0.8	0.714167
0.9	0.737710
1.0	0.760217
1.1	0.781627
1.2	0.801892
1.3	0.820978
1.4	0.838864
1.5	0.855541
1.6	0.871014
1.7	0.885299
1.8	0.898420
1.9	0.910413
2.0	0.921319
2.25	0.944167
2.5	0.961428
2.75	0.974067
3.0	0.983039
3.5	0.993329
4.0	0.997658
4.01	1.000000

#### MARSSIM Table 5.2, $\alpha = 0.05$ , $\beta = 0.10$

α

α (or β)	$Z_{1-\alpha}$ (or $Z_{1-\beta}$ )
0.005	2.576
0.01	2.326
0.015	2.241
0.025	1.960
0.05	1.645
0.10	1.282
0.15	1.036
0.2	0.842
0.25	0.674
0.30	0.524

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Hematite	Procedure: HDP-PR	-FSS-721, Final Statu	as Survey Data Eval	uation		
Pecommissioning Project				Revision:	10 Appendix G-1 Page 1 of 2	,
FINAL	STATUS SURVEY I	APPENDIX ( DATA QUALITY ()		IEW CHE	CKLIST	
Survey Area:	LSA 12	Description:	Laydown Area, Pl	ant Soils SE	EA	
Survey Unit:	06	Description:	Class I Laydown	Land Area i	n "Area 13"	
to data and	neasurements and/or a lysis for FSS been ir with Section 8.1 of th	dividually reviewed		Yes 🖂	No 🗌	
	systematic measurem t the locations specifi s?			Yes 🔀	No 🗌	
	cans surveys been the FSSP and the FSSP			Yes 🔀	No 🗌	
	ased measurements a ions specified in the F			Yes 🔀	No 🗌 NA 🗌	
	icate and/or split sam each location designation			Yes 🔀	No 🗌 NA 🗌	
capable of	instruments used to detecting the ROCs riate investigation leve	or gross activity at a		Yes 🔀	No	
analyze da	alibration of all instru ta, current at the timusing a NIST traceab	e of use and were the		Yes 🔀	No	
	nstruments successfu hired, after use on the			Yes 🔀	No	
9. Do the san	ples match those ider	ntified on the chain of	custody?	Yes 🖂	No 🗌 NA 🗌	
	Sample Results meet SS-703, Final Status			Yes ⊠*	No 🗌	
11. Are all La	poratory QC paramete	rs within acceptable l	imits?	Yes 🖂	No 🗌	
corrective actio	e response to any of ns that were taken to r ne QC duplicate samp red Control Limit, resp	esolve the discrepand	cy.	-	-	

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Decommissioning Project					Revision: 10	Appendix G-1, Page 2 of 2
FINAL	STATUS SURV		PPENDIX G UALITY OI		EVIEW CHEC	KLIST
Survey Area:	LSA 12				a, Plant Soils SEA	
Survey Unit:	06	<u> </u>	Description:	Class 1 Laydo	wn Land Area in	"Area 13"
Discrepancy:	N/A					
·						
- <u></u>						
	<u></u>	. •	-			
		•		•		
Corrective Acti	ons Taken: <u>N/A</u>		· · · · · · · · · · · · · · · · · · ·			
Corrective Acti	ons Taken: <u>N/A</u>	A	· · · · · · · · · · · · · · · · · · ·			
Corrective Acti	ons Taken: <u>N/A</u>	<u> </u>				· · · · · · · · · · · · · · · · · · ·
Corrective Acti	ons Taken: <u>N/A</u>	A		· · · · · · · · · · · · · · · · · · ·		· · · · · · · · · · · · · · · · · · ·
11. Have-the	ons Taken: <u>N/A</u>	resolved the	discrepancy v		· · · · · · · · · · · · · · · · · · ·	
11. Have the a. If "No"	corrective actions	resolved the o	discrepancy v RSO.	vith the data?	· · · · · · · · · · · · · · · · · · ·	
<ul> <li>11. Have the oracle of the following of the foll</li></ul>	corrective actions ', then forward the ving questions wi nswer to question	resolved the the test of t	discrepancy v RSO. d by the RSO	vith the data?	Yes 🗌 N	
<ul> <li>11. Have the oral of "No"</li> <li>12. The follow</li> <li>a. If the a still va</li> <li>b. If "No"</li> </ul>	corrective actions ', then forward the ving questions wi nswer to question	resolved the is form to the !! be answered 1 11 was "No" sting valid me	discrepancy w RSO. d by the RSO ', then is the a easurements of	vith the data?	Yes 🗌 N Yes 🗌 N	No 🗌 NA 🛛
<ul> <li>11. Have the oral of the algorithm of the oral of the algorithm of the oral of t</li></ul>	corrective actions ', then forward th ving questions wi nswer to question lid? ', then are the exis	resolved the o is form to the !! be answered to 11 was "No" sting valid me e compliance f acquisition of	discrepancy v RSO. d by the RSO ', then is the a casurements c for the survey additional mo	vith the data?	Yes I N Yes I N Yes I N	No 🗌 NA 🕅 No 🗌 NA 🕅 No 🗌 NA 🕅
<ul> <li>11. Have the oral of the analysis of</li></ul>	corrective actions r, then forward the ving questions wi nswer to question lid? r, then are the exist of the demonstrate r, then direct the a	resolved the o is form to the !! be answered to 11 was "No" sting valid me e compliance f acquisition of	discrepancy v RSO. d by the RSO ', then is the a casurements c for the survey additional mo	vith the data?	Yes I N Yes I N Yes I N	No 🗌 NA 🕅 No 🗌 NA 🕅 No 🗌 NA 🕅

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# 32.0 CONCLUSION LSA 12-06

An adequate quantity and quality of radiological surveys and samples, as well as the corresponding laboratory analysis has been performed, evaluated and documented to demonstrate that the dose associated with all sources within SU LSA 12-06 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402.

		LOA 12-00 SOF and	Dose Summ	auon		
	AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	BURIED PIPING	REUSE SOIL	TOTAL
SOF	0.11	N/A	0.16	N/A	N/A	0.27
DOSE	2.75 mrem/year	N/A	4.0 mrem/year	N/A	N/A	6.75 mrem/year

Table 32-1LSA 12-06 SOF and Dose Summation

Hematite	FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12,		
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#### 33.0 FINAL STATUS SURVEY DESIGN LSA 12-07

This section of the report describes the method for determining the number of samples required for the FSS of LSA 12-07 as well as summarizing the applicable requirements of the FSS Plan. These include the  $DCGL_W$ , scan survey coverage, and IAL. The radiological instrumentation used in the FSS of LSA 12-07 and the detection sensitivities are also discussed.

#### 33.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 12-07 were driven by the type (Open Land) and Class (Class 1) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development*, November 2015.

#### **33.1.1 Surrogate Evaluation Areas**

A discussion of Surrogate Evaluation Areas is given in the FSSFR Volume 3, Chapter 1, Section 5.0, *Final Status Survey Design*.

#### 33.1.2 DCGL<sub>w</sub>

During the FSS design process a review was performed of the RASS data for LSA 12-07. The RASS data was used as confirmation that no known areas of residual radioactivity remained within the survey areas that exceeded the Uniform Stratum DCGL<sub>w</sub>. Therefore the Uniform Stratum DCGL<sub>w</sub> was selected for use in demonstrating compliance with the release criteria.

#### 33.1.3 GWS Coverage

As a Class 1 SU, LSA 12-07 was required to undergo a 100% GWS.

#### **33.1.4 Instrumentation**

Radiological instrumentation selected for performance of GWS within LSA 12-07 was the Ludlum 44-10 2" x 2" NaI detectors, coupled to a Ludlum 2221 scaler-ratemeter.

#### 33.1.5 Scan Minimum Detectable Concentration

Scan MDCs for LSA 12-07 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD- FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. As background levels were approximately 10,000 cpm within LSA 12-07, the scan MDC calculation for total uranium given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.2.6.d, was applied:

Scan MDC (total uranium) = 
$$\frac{1}{\left(\left(\frac{f_U - 234}{3659 \, pCi/g}\right) + \left(\frac{f_U - 235}{2.32 \, pCi/g}\right) + \left(\frac{f_U - 238}{30.6 \, pCi/g}\right)\right)}$$

Equation 33-1

To determine isotopic Uranium fractions HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* assumes that the average LSA enrichment is 4% or less. Based on the

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systematically collected RASS samples in LSA 12-07, the average enrichment for the SU was 2.96%. All other Scan MDC parameters agreed upon between Westinghouse and the NRC were applied (e.g. use of a 2 in air gap, scan rate of 1 ft/sec, 0.75 surveyor efficiency), therefore no subsequent changes to the calculated Scan MDCs need to be made.

Prospectively calculated Scan MDCs for 2" x 2" NaI detectors that were used in LSA 12-07 are shown below:

# Table 33-1Scan MDCs for 2" x 2" NaI detector, 10,000 cpm background: LSA 12-07

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 12-07	40.9	46.6	0.87	2.8	1.21	3.0

\*DCGL<sub>w</sub> includes background concentrations of 0.9 pCi/g for Ra-226 (no ingrowth) and 1.0 pCi/g for Th-232. DCGLw values are based on the Uniform Stratum release criteria.

The values in Table 33-1 reflect those presented in the FSS Plans prepared for the SU prior to FSS.

#### **33.1.6 Investigation Action Level**

FSSFR Volume 3, Chapter 1, Section 6.1.3, *Investigation Action Level (IAL)*, provides a discussion in regards to the IAL. The basis of the IAL is detailed in HDP memorandum, HEM-15-MEMO-021 "Evaluation of the Scan IAL for Class 1 areas at the Westinghouse Hematite Site". The IAL used during the GWS of LSA 12-07 was established at 4,000 ncpm.

#### 33.1.7 LSA 12-07 FSS Design Summary

The FSS Plans for LSA 12-07 can be found in Appendix L. Table 33-2 presents an overall FSS design and implementation summary for LSA 12-07.

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FSS Design Summary for LSA 12-07

Scan Coverage		100% exposed soil and rock	
· · · · ·		40.9 pCi/g total Uranium (based on a 10,000	
Scan MDC		-	ckground); 0.87 pCi/g Th-232; 1.21
		pCi/g Ra-226*	
Investigation Action Level (IAL)		4,000 net cpm **	
Systematic Sampling Locations:	-		
Depth	Number of Samp	le	Comments
0-15 cm (Surface)	8		
15 cm – 1.5 m (Root)	8		These samples will be taken on a random-start systematic grid.
> 1.5m (Excavation)	8		random-start systematic grid.
<b>Biased Survey/Sampling Location</b>	s:		· ·
<u>au na </u>			
of "sidewall": sidewall candidates	-		-
A minimum of one (1) discretionary of "sidewall": sidewall candidates least 12" in height. Instrumentation: Ludlum 2221 with 44-10 (2x2 Nal	for sampling must be	e vertica	lected based on the following definition al or near vertical (> 45° angle) and a GWS and to obtain static count rates a asurement locations
A minimum of one (1) discretionary of "sidewall": sidewall candidates least 12" in height. Instrumentation: Ludlum 2221 with 44-10 (2x2 NaI collimation for investigations *Values based on information prov Scanning Minimum Detectable Conf for total Uranium reflects a conserv	for sampling must be ) detector; with Us bia ided in HDP-TBD-FS acentrations (MDC) for vative assumption of	e vertica sed for ( ased me SS-002, for Final 4% enr	al or near vertical (> 45° angle) and a

FSS was performed in accordance with procedure HDP-PR-FSS-711, Final Status Surveys and Sampling of Soil and Sediment.

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#### 34.1 Gamma Walkover Survey

#### 34.1.1 Instrumentation

The selected instrumentation to perform the GWS in LSA 12-07 was a 2" x 2" NaI detector in combination with a Ludlum 2221 rate meter. Each NaI instrumentation set was interfaced with a Trimble DGPS and handheld data logger.

Prior to the first field use of the GWS instrumentation, initial set-ups were performed. Also, daily pre- and post-use source checks were performed for each day that GWS was performed within the SU. Initial set-ups, daily source checks, and control charting were performed according to the requirements of HDP-PR-HP-416, *Operation of the Ludlum 2221 for Final Status Survey*.

#### 34.1.2 GWS Performance

All GWS measurements on the excavation floor and sidewalls collected with the NaI detector(s) were connected to a Trimble DGPS and with a hand-held data logger. The logging frequency in the survey unit was 1 GWS measurement per second. Each gross gamma measurement is correlated to a set of coordinates based on the Missouri East State Plane, NAD 1983.

The GWS requirements involved moving the NaI detector in a side-to-side fashion no faster than 1 foot per second while holding the probe as close as possible to the excavation surface (nominally 1", but not to exceed 3"). At the same time, the technician was required to slowly advance, causing the detector to trace out a serpentine path over the excavation surface.

FSS Technicians performing GWS in LSA 12-07 used the 4,000 ncpm IAL as a field guide to know when to slow or pause the GWS for more deliberate investigation. If during the GWS, audible count rates noticeably increase above the general area average (i.e., > minimum detectable count rate), FSS Technicians were required to pause momentarily and observe count rates. If sustained count rates approached the IAL, further focused investigation was conducted within the locally elevated area.

To use the IAL effectively, FSS Technicians first determined the local background count rate before starting the GWS. Although the ambient gamma level may vary across the SU due to excavation geometry and relative distance from contaminated materials in nearby remedial excavations, the average background rate (measured at waist level) within the LSA ranged between 10,000 and 11,000 gcpm. Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 14,000 to 15,000 gcpm, FSS technicians slowed or paused the GWS for more careful investigation of the small areas of elevated activity before deciding if "flagging" a point for potential biased sampling was warranted.

Hard to reach areas, and non-typical areas were surveyed manually as necessary in order to assess the potential for an area of elevated residual activity over 100% of the exposed ground surface.

After the GWS survey was complete, the GPS/GWS data was reviewed by Radiological Engineering and the Health Physics Technician performing the survey to determine if possible areas of elevated residual activity remained within the SU that required biased sample

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investigation. Areas that were flagged by the HP Technician were considered, as well as a statistical evaluation of the GWS data set. The statistical evaluation determined the mean count rate and standard deviation associated with the GWS and then could be used to identify any areas that exceeded 3 standard deviations above the mean. The number of biased samples to be collected and the locations are based on flagged locations exceeding the IAL, the statistical evaluation of the GWS data set, and the professional judgment of Radiological Engineering.

# 34.2 Soil Sampling

# 34.2.1 Systematic Soil Sampling Summary

Table 34-1 provides a summary of systematic sampling by stratum for LSA 12-07.

	Systematic Sampling Summary by Stratum for LSA 12-07							
	LSA	SU Area,						
		planar $(m^2)$	Surface	Root	Deep (Excavation)	QC		
	12-07	1,996	8	8	8*	2		

# Table 34-1Systematic Sampling Summary by Stratum for LSA 12-07

\*Excavation samples were collected and archived, analysis only required if a overlying Root sample exceeds a 0.5 SOF

#### 34.2.2 Systematic Sampling LSA 12-07

Within LSA 12-07, there were 8 systematic locations in which the surface stratum [0 - 15 cm) was sampled in the SU. The underlying root stratum was sampled at all 8 locations. Excavation stratum samples were collected and archived, but were not required to be analyzed since no root stratum sample exceeded a 0.5 Uniform SOF.

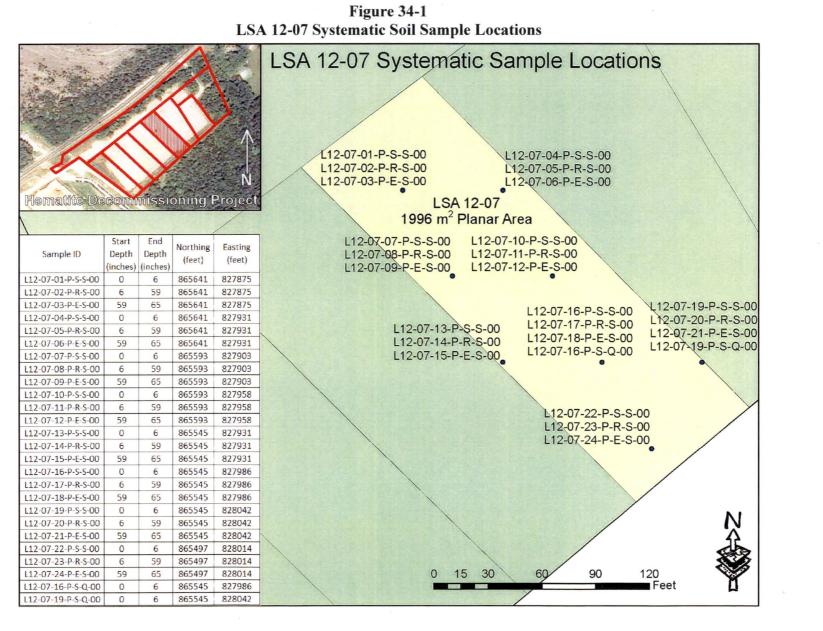
Given a planar area of 1,996  $m^2$  for LSA 12-07 and an eight - point systematic triangular grid, the point-to-point distance within each row was 16.9 m with spacing of 14.6 m between each of the parallel grid rows within the SU.

While there were eight (8) systematic locations on the LSA 12-07 sampling grid, a total of eighteen (18) samples were collected and analyzed at these locations, including:

- Eight (8) samples collected and analyzed within the surface stratum
- Eight (8) samples collected and analyzed within the root stratum
- Zero (0) samples analyzed within the excavation, or "deep" stratum
- Two (2) QC field replicate

Figure 34-1 presents the map of the eight systematic sample locations which were sampled within LSA 12-07. The inset table notes the location coordinates (Missouri East, NAD 1983) and collection intervals for each systematic location.

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]	Decommissioning	FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12, Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)			
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Figure 34-2 below presents a tabular listing of all FSS samples collected within LSA 12-07 with associated IDs, sample types, collection intervals, coordinates, and notes.

Figure 34-2						
FSS Sample Locations and Coordinates for LSA 12-07						

Hematite Decommissioning Project		Procedure	: HDP-PR-FSS-	-701, Final Stat	tus Survey Plan	Development	
						Revision: 10	Appendix P-4, Page 1 of
		SS SAMDI	F & MEASUE	APPENDIX I		TOODDINATES	
Survey Area:	LSA		S SAMPLE & MEASUREMENT LOCATIONS & COORDINATES         2       Description:         Laydown Area, Plant Soils SEA				
Survey Unit:	07	,	Description:         Class 1 Laydown Land Area in "Area 13"				
Survey Type:	FS			Class 1			
Measurement or Sample ID	Surface or CSM	Туре	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes
L12-07-01-P-S-S-00	Uniform	S	431.5	431.0	865641	827875	Surface 6-inch grab
L12-07-02-P-R-S-00	Uniform	S	431.0	426.5	865641	827875	Root 59-inch composite
L12-07-04-P-S-S-00	Uniform	S	431.2	430.7	865641	827931	Surface 6-inch grab
L12-07-05-P-R-S-00	Uniform	S	430.7	426.3	865641	827931	Root 59-inch composite
L12-07-07-P-S-S-00	Uniform	S	430.7	430.2	865593	827903	Surface 6-inch grab
L12-07-08-P-R-S-00	Uniform	S	430.2	425.8	865593	827903	Root 59-inch composite
L12-07-10-P-S-S-00	Uniform	S	430.2	429.7	865593	827958	Surface 6-inch grab
L12-07-11-P-R-S-00	Uniform	S	429.7	425.3	865593	827958	Root 59-inch composite
L12-07-13-P-S-S-00	Uniform	S	429.8	429.3	865545	827931	Surface 6-inch grab
L12-07-14-P-R-S-00	Uniform	S	429.3	424.8	865545	827931	Root 59-inch composite
L12-07-16-P-S-S-00	Uniform	S	430.3	429.8	865545	827986	Surface 6-inch grab
L12-07-17-P-R-S-00	Uniform	S	429.8	425.4	865545	827986	Root 59-inch composite
L12-07-19-P-S-S-00	Uniform	S	429.9	429.4	865545	828042	Surface 6-inch grab
L12-07-20-P-R-S-00	Uniform	S	429.4	424.9	865545	828042	Root 59-inch composite
L12-07-22-P-S-S-00	Uniform	S	429.9	429.4	865497	828014	Surface 6-inch grab
L12-07-23-P-R-S-00	Uniform	S	429.4	425.0	865497	828014	Root 59-inch composite
L12-07-16-P-S-Q-00	Uniform	Q	430.3	429.8	865545	827986	Surface 6-inch grab
L12-07-19-P-S-Q-00	Uniform	Q	429.9	429.4	865545	828042	Surface 6-inch grab
L12-07-25-P-S-B-00	Uniform	В	429.9	429.4	865526.2	828056.9	Biased 6-inch grab

Green shaded samples are the samples at each sample location, for use in WRS Test.

\*Elevations are in feet above mean sea level.

\*\* Missouri - East State Plane Coordinates [North American Datum (NAD) 1983]

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R

CSM: Three-Layer (Surface-Root-Excavation) or Uniform DCGLs used

Type: Systematic = S, Biased = B; QC =Q; Investigation = I

Quality Record

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# 34.3 Biased Soil Sampling

As discussed in FSSFR Volume 3, Chapter 1, Section 6.1.3, there are three key methods for identifying areas for biased soil sampling, the IAL, the Z-score of the FSS GWS, and the professional judgment of the HP Staff. For LSA 12-07 one (1) biased sample location was selected within the SU based on the evaluation of the GWS survey data and HP Technician professional judgment. The biased location represented the maximum GWS measurement encountered within the SU. Biased samples are collected at the prescribed location to a depth of 6 inches below the exposed ground surface.

#### 34.4 Judgmental/Sidewall Sampling for Tc-99

As an un-excavated SU, no Tc-99 sidewall sampling was necessary for LSA 12-07.

#### 34.5 Quality Control Soil Sampling

Two QC field duplicate sample point were randomly selected and collected at systematic locations L12-07-16 and L12-07-19 for LSA 12-07.

#### 35.0 FINAL STATUS SURVEY RESULTS LSA 12-07

#### 35.1 Gamma Walkover Survey

Post-processed GPS coordinate data is accurate to within  $\pm 0.1$  m for the handheld GPS models used during the GWS. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same GPS location during the walkover, the most elevated radiological measurements are plotted "on top" (e.g. if any sidewalls featured more elevated readings than the floor directly below, the sidewall radiological measurements would overlie the lower floor readings).

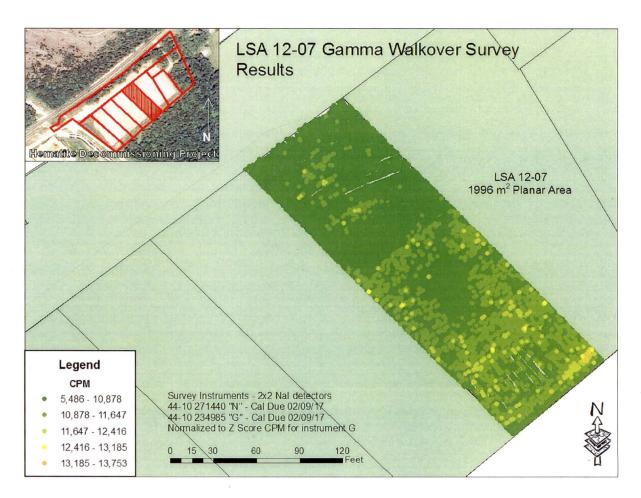
GWS measurements were collected in LSA 12-07 between May 6, 2016, and May 15, 2016.

#### 35.1.1 GWS Results for LSA 12-07

For LSA 12-07, GWS count rates ranged between 5,486 gcpm and 13,753 gcpm, with a mean count rate of 10,110 gcpm. The median count rate was 11,943 gcpm and the standard deviation was 769 cpm. Figure 35-1 below presents a map of the complete GWS data set.

Hematite	FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12,				
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Figure 35-1 Colorimetric GWS Plot for LSA 12-07

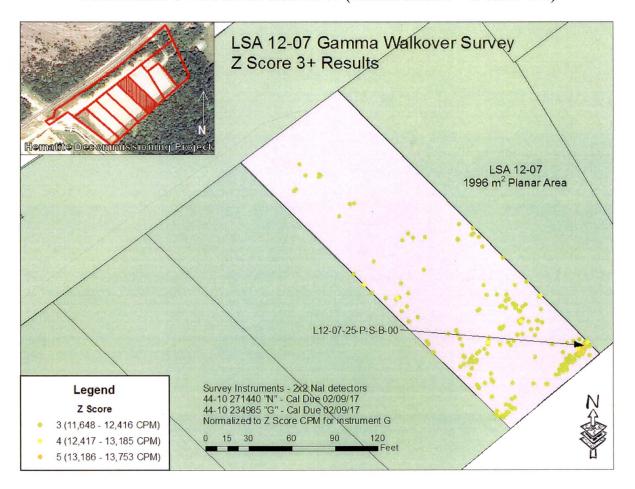


An evaluation of the entire GWS data set was performed to evaluate those small areas of elevated activity which exceeded three (3) standard deviations above the GWS mean measurement, (i.e., "+3 Z-score"). Two locations, L12-07-25, were selected for biased sample collection. These biased locations represented the maximum GWS measurements encountered within the SU.

Figure 35-2 below presents a map of the +3 Z-score GWS measurements within LSA 12-07, including the selected biased sampling locations (ID: L12-07-25-P-S-B-00).

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Figure 35-2 Colorimetric GWS Plot for LSA 12-07 (Measurements > Z-score of 3)



All GWS data collected in LSA 12-07 was datalogged and post-processed in Graphical Information Software (GIS).

#### 35.1.2 GWS Coverage Results LSA 12-07

FSSFR Volume 3, Chapter 1, Section 6.1.4, *Exposed Surfaces versus Accessible Surfaces*, provides a discussion and the criteria for evaluating the GWS coverage of a SU during FSS. Although 100% of accessible areas underwent GWS, the post survey processing of the GPS data indicated that the GWS covered 98.64% of the SU (see Table 35-1). As the evaluation indicates that the GPS coverage exceeded 95% with no readings approaching or exceeding the IAL of 4,000 net cpm in the vicinity of any apparent GPS coverage gaps, the GWS coverage for the SU has been evaluated to meet the intent of the "100% GWS coverage" requirement.

Decommissioning Su	FSSFR Volume 3, Chapter 9: Survey Area Release Record for La Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 1	•
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# Table 35-1 GWS Gap Analysis LSA 12-07

	Total SU	GWS Gap	Gap	GWS	MARSSIM
	Pixels	Pixels	Percentage	Coverage	Class
LSA 12-07	155,326	2,106	1.36	98.64	1

#### 35.2 Soil Sample Results LSA 12-07

#### 35.2.1 Surface Soil Sample Results LSA 12-07

There were eight systematic samples collected within the surface stratum (0 - 15 cm) of LSA 12-07. Additionally two QC samples and one biased sample were collected in the topmost layer of soil. The maximum Uniform SOF result for the surface samples was 0.08.

Appendix E presents the analytical results and associated statistics for all FSS surface samples collected within LSA 12-07.

#### 35.2.2 Subsurface Soil Sample Results LSA 12-07

There were eight systematic locations within LSA 12-07 where root stratum composite sampling was necessary. The root stratum zone is between 0.15 and 1.50 m below final grade surface. At each of the eight root stratum composite sampling locations, the top six inches (1.50 - 1.65 m below final grade surface) of the underlying excavation stratum was also collected and archived, however these excavation samples were not required to be analyzed as no overlying root stratum sample exceeded a 0.5 SOF. The maximum SOF result of the subsurface samples collected in LSA 12-07 was 0.15.

#### 35.2.3 WRS Evaluation

Per Step 7.8.3 of HDP-PR-FSS-721 *Final Status Survey Data Evaluation*, the Wilcoxon Rank Sum (WRS) statistical test was not required for LSA 12-07 since the difference between the maximum SU data set gross SOF and the minimum background area SOF was less than one using the Uniform Stratum criteria. However, for illustrative purposes, the WRS evaluation was still performed for LSA 12-07. All systematically collected samples regardless of depth are used to perform the WRS Test, however biased and QC sample results are not utilized in the WRS Test. The 16 systematically collected samples in LSA 12-07 were ranked against the adjusted activity concentrations of the 32 samples collected within the Background Reference Area. The SU passed the WRS Test since the ranked sum of the reference area ranks, or test statistic  $W_R$ , (1040) was greater than the critical value (860) for the test. As such, the null hypothesis that the SU average concentration is greater than the DCGL<sub>W</sub> was rejected. The WRS evaluation is also included in Appendix E.

#### 35.2.4 Graphical Data Review LSA 12-07

Table 35-2 below presents summary results for the all systematically collected samples (includes surface, and root, but not biased or QC samples) collected within LSA 12-07, and the associated

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SOF when compared to the Uniform Stratum  $DCGL_ws$ . The arithmetic average concentration resulted in a SOF of 0.06.

Statistic	Ra-226 DCGL = 1.9 BKG = 1.07 (pCi/g)	Tc-99 DCGL = 25.1 (pCi/g)	Th-232 DCGL = 2.0 BKG = 1.0 (pCi/g)	U-234 DCGL=195.4 (pCi/g)	U-235 DCGL=51.6 (pCi/g)	U-238 / DCGL=168.8 (pCi/g)	Sample SOF (Uniform DCGL)
Average	0.009	0.124	0.059	2.151	0.060	0.982	0.06
Minimum	0.00 ( <bkg)< td=""><td>0.00 (NEG)</td><td>0.00 (<bkg)< td=""><td>0.475</td><td>-0.145</td><td>0.475</td><td>0.01</td></bkg)<></td></bkg)<>	0.00 (NEG)	0.00 ( <bkg)< td=""><td>0.475</td><td>-0.145</td><td>0.475</td><td>0.01</td></bkg)<>	0.475	-0.145	0.475	0.01
Maximum	0.090	0.406	0.200	5.759	0.318	1.500	0.15

1 able 35-2
LSA 12-07 FSS Sample Data Summary and Calculated SOF Values (Systematic)

Notes:

1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.

2. Average SOF for data set calculated using average radionuclide concentrations.

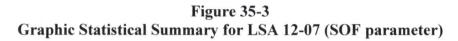
3. U-234 values are inferred from the U-235/U-238 ratio.

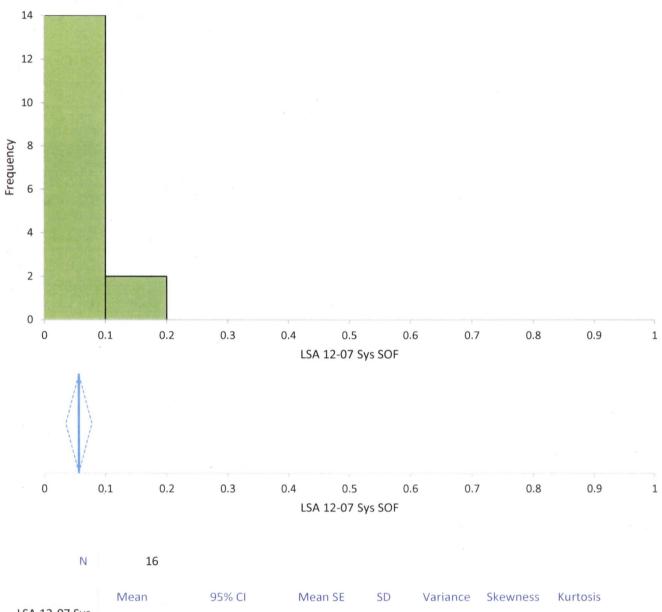
Section 8.2.2.2 of MARSSIM recommends a graphical review of FSS analytical data, to include at a minimum, a posting plot and a histogram. A frequency plot, or histogram, is a useful tool for examining the general shape of a data distribution. This plot is a bar chart of the number of data points within a certain range of values. The frequency plot will reveal any obvious departures from symmetry, such as skewness or bimodality (two peaks), in the data distribution for the survey unit. The presence of two peaks in the survey unit frequency plot may indicate the existence of isolated areas of residual radioactivity.

Figure 35-3 presents the overall statistical metrics for the SOF parameter for the 16 systematically collected samples from LSA 12-07. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 12-07. The middle graph presents the mean SOF (0.06 as indicated by the blue vertical line) of the sample population and the 95% confidence interval of the mean SOF represented by the blue diamond which is 0.04 to 0.08. The 97.87% confidence interval based on the median (also 0.06) of the sample results is 0.02 to 0.18. The bottom two charts present the various statistical metrics of the LSA 12-07 SOF data set, including the mean, median, standard deviation, minimum, maximum, confidence intervals, etc.

Figure 35-3 exhibits no unusual symmetry or bimodality concerns for the LSA 12-07 data associated with the systematically collected measurement locations.

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Decommissioning	Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)								
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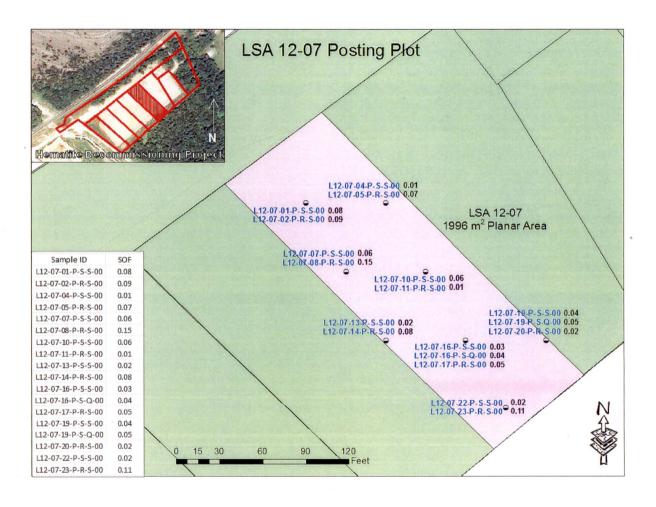


LSA 12-07 Sys SOF	0.06	0.04	to 0.08	0.010	0.04	0.00	0.9	0.72
	Minimum	1st quartile	Median	97.87%	% CI	3rd quartile	Maximum	IQR
LSA 12-07 Sys SOF	0.01	0.02	0.06	0.02	to 0.08	0.08	0.2	0.06

	FSSFR Volume 3, Chapter 9: Survey Area Release Record for La Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 2 Revision: 1	
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A posting plot is simply a map of the survey unit with the data values (in this case the SOF values for each systematically collected sample) entered at the measurement locations. This potentially reveals heterogeneities in the data – especially possible patches of elevated residual radioactivity. The posting plot for LSA 12-07 is presented below in Figure 35-4. Figure 35-4 shows no unusual patterns in the data.

#### Figure 35-4 Posting Plot for LSA 12-07 Systematic Measurement Locations



Appendix E to this report presents the complete analytical data set (in Microsoft Excel format) used to derive the summary statistics presented in Table 35-2, Figure 35-3, and Figure 35-4 above. A summary of the analytical data is presented in Table 35-3 below. Appendix S to this report presents the TestAmerica Analytical Laboratory soil sample reports.

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												Fi	nal S	tatus	Survey	y Analy	vtical	Data:	LSA 1	2-07													
																		×															
		0			TestAmerica Analytical Results																												
2	(£f)	s, <b>Q</b> C)		S. S. S. L.		525									- S- (- )							a la la la	-					- Contraction		N.			and the state
						1	rc-99					Th-2	32			li	nferred	U-234		1100	U-23	5			U-23	38		Enr.	SOF				
Sample ID	Sample Depth (ft)	Type (Systematic, B	Result	Uncertainty	MDC	Qualifier	Net Result*	Corrected Result	Result	Corrected Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Net Result**	Corrected Result	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Enrichment (%)	SOF
L12-07-01-P-S-S-00	0.00	S	0.733	0.128	0.0837	N/A	-0.337	0.000	0.182	0.182	0.067	0.242	U	1.12	0.191	0.0992	N/A	0.120	0.120	1.525	NA	NA	NA	0.0805	0.281	0.468	U	0.84	0.349	0.9	U	1.5	0.08
L12-07-02-P-R-S-00	0.50	S	1.1	0.175	0.0868	N/A	0.030	0.030	0.406	0.406	0.056	0.228	N/A	1.03	0.171	0.152	N/A	0.030	0.030	5.759	NA	NA	NA	0.318	0.194	0.219	N/A	0.984	0.762	0.989	U	4.8	0.09
L12-07-04-P-S-S-00	0.00	S	0.848	0.143	0.0748	N/A	-0.222	0.000	0.127	0.127	0.124	0.23	U	0.876	0.17	0.127	N/A	-0.124	0.000	0.475	NA	NA	NA	-0.145	0.209	0.672	U	0.475	0.29	1.55	U	0.7	0.01
L12-07-05-P-R-S-00	0.50	S	0.965	0.13	0.0489	N/A	-0.105	0.000	-0.0889	0.000	0.051	0.24	U	1.13	0.172	0.119	N/A	0.130	0.130	0.887	NA	NA	NA	-0.115	0.112	0.495	U	0.887	0.283	0.766	N/A	0.7	0.07
L12-07-07-P-S-S-00	0.00	S	0.837	0.133	0.0763	N/A	-0.233	0.000	0.307	0.307	0.182	0.263	N/A	1.06	0.184	0.123	N/A	0.060	0.060	1.330	NA	NA	NA	-0.018	0.262	0.421	U	1.33	0.506	0.745	N/A	0.7	0.06
L12-07-08-P-R-S-00	0.50	S	1.16	0.18	0.0684	N/A	0.090	0.090	-0.035	0.000	0.028	0.233	U	1.2	0.204	0.126	N/A	0.200	0.200	0.840	NA	NA	NA	-0.136	0.208	0.697	U	0.84	0.342	0.965	U	0.7	0.15
L12-07-10-P-S-S-00	0.00	S	0.789	0.12	0.0616	N/A	-0.281	0.000	0.394	0.394	0.139	0.22	N/A	0.885	0.128	0.0901	N/A	-0.115	0.000	5.694	NA	NA	NA	0.314	0.129	0.196	N/A	1.37	0.504	0.74	N/A	3.5	0.06
L12-07-11-P-R-S-00	0.50	S	0.962	0.157	0.082	N/A	-0.108	0.000	-0.0975	0.000	0.071	0.232	U	0.937	0.22	0.162	N/A	-0.063	0.000	0.683	NA	NA	NA	-0.009	0.371	0.626	U	0.683	0.282	1.59	U	0.7	0.01
L12-07-13-P-S-S-00	0.00	S	0.942	0.143	0.0564	N/A	-0.128	0.000	0.172	0.172	0.065	0.22	U	0.961	0.155	0.132	N/A	-0.039	0.000	1.629	NA	NA	NA	0.0869	0.332	0.552	U	0.791	0.301	0.78	N/A	1.7	0.02
L12-07-14-P-R-S-00	0.50	S	1.01	0.137	0.0637	N/A	-0.060	0.000	-0.115	0.000	0.036	0.24	U	1.13	0.174	0.0856	N/A	0.130	0.130	1.611	NA	NA	NA	0.0855	0.0944	0.512	U	0.819	0.337	0.816	N/A	1.6	0.08
L12-07-16-P-S-S-00	0.00	S	0.841	0.132	0.0717	N/A	-0.229	0.000	0.204	0.204	0.074	0.22	U	0.985	0.149	0.101	N/A	-0.015	0.000	2.249	NA	NA	NA	0.116	0.194	0.343	U	1.5	0.516	0.745	N/A	1.2	0.03
L12-07-17-P-R-S-00	0.50	S	0.946	0.126	0.0583	N/A	-0.124	0.000	-0.073	0.000	0.063	0.228	U	1.08	0.16	0.114	N/A	0.080	0.080	1.809	NA	NA	NA	0.0986	0.108	0.176	U	0.628	0.21	1.33	U	2.4	0.05
L12-07-19-P-S-S-00	0.00	S	0.952	0.151	0.0759	N/A	-0.118	0.000	0.0359	0.036	0.089	0.211	U	0.984	0.163	0.119	N/A	-0.016	0.000	5.758	NA	NA	NA	0.318	0.131	0.191	N/A	1.19	0.364	0.889	N/A	4.0	0.04
L12-07-20-P-R-S-00	0.50	S	1.02	0.155	0.0737	N/A	-0.050	0.000	-0.0533	0.000	0.102	0.222	U	1.03	0.188	0.0947	N/A	0.030	0.030	0.868	NA	NA	NA	-0.006	0.0818	0.386	U	0.868	0.29	0.773	N/A	0.7	0.02
L12-07-22-P-S-S-00	0.00	S	0.673	0.12	0.0731	N/A	-0.397	0.000	0.153	0.153	0.051	0.222	U	0.803	0.184	0.168	N/A	-0.197	0.000	1.260	NA	NA	NA	-0.132	0.189	0.632	U	1.26	0.542	0.809	N/A	0.7	0.02
L12-07-23-P-R-S-00	0.50	S	1.09	0.153	0.0702	N/A	0.020	0.020	-0.0672	0.000	0.073	0.224	U	1.16	0.163	0.0879	N/A	0.160	0.160	2.041	NA	NA	NA	0.107	0.121	0.187	U	1.25	0.497	0.744	N/A	1.4	0.11
L12-07-16-P-S-Q-00	0.00	Q	0.85	0.142	0.0762	N/A	-0.220	0.000	-0.0485	0.000	0.03	0.231	U	0.959	0.175	0.115	N/A	-0.041	0.000	4.952	+ +	NA	NA	0.268	0.13	0.185	N/A	1.99	0.866	0.96	N/A	2.1	0.04
L12-07-19-P-S-Q-00	0.00	Q	0.86	0.121	0.0582	N/A	-0.210	0.000	0.141	0.141	0.03	0.232	U	0.971	0.145	0.0867	N/A	-0.029	0.000	6.122	+ +	NA	NA	0.337	0.133	0.174	N/A	1.6	0.54	0.78	N/A	3.2	0.05
L12-07-25-P-S-B-00	0.00	В	0.884	0.147	0.077	N/A	-0.186	0.000	0.107	0.107	0.080	0.218	U	1.010	0.178	0.101	N/A	0.010	0.010	0.605	NA	NA	NA	0.023	0.123	0.598	U	1.240	0.583	0.888	N/A	0.3	0.02
Systematic Mi	inimum				0.00	00				(	0.000					0.00	00				0.4	75			-0.14	15			0.47	75	_	1.7	0.01
Systematic Ma	aximum	-			0.09	90				(	0.406					0.20	00				5.7	59			0.31	8			1.50	00		(%)	0.15
Systematic I	Mean	1. Con 1.			0.00	09				(	0.124	-				0.05	59				2.1	51			0.06	0			0.98	32		rage	0.06
Systematic N	ledian	29-29			0.00	00				(	0.081					0.03	30				1.5	68		0.083				0.878				Aver	0.06
Systematic Standa	rd Deviati	on	1. · · ·		0.02	23				(	0.145					0.06	68				1.8	45			0.15	7			0.29	98		En	0.04
S. M. Chinak in	1315	2272	With in	growth, u	se Ra226	6 bkg =	a late	1.07	1.2.5		S. S.	1	2015	Th232	bkg =	1.0	2					S. Links	1440	a di				S	SIGGA	12.52			a la la la la

# Table 35-3Final Status Survey Analytical Data: LSA 12-0

NOTES:

Gross results in units of pCi/g.

\* Background with ingrowth (1.07 pCi/g) subtracted from gross result.

\*\*Background (1.0 pCi/g) subtracted from gross result.

U Qualifier: Result is less than the sample detection limit.

All uncertainty values are reported at the 2-sigma confidence level.

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#### 35.2.5 Biased Soil Sample Result LSA 12-07

One (1) biased sample was collected from LSA 12-07. The sample collected at location L12-07-25 represented the maximum GWS measurement (13,753 gcpm) within the SU, and had a result of 0.02 Uniform SOF.

#### 35.2.6 Quality Control Soil Sample Result LSA 12-07

Two QC field duplicate sample points were randomly selected for LSA 12-07 which were collected at systematic locations L12-07-16 and L12-07-19.

For the 17 samples (i.e., 16 systematic + 1 biased) collected within LSA 12-07, two field duplicate samples were collected. This frequency equates to 11.8%, (i.e. 2/17). Form HDP-PR-FSS-703-1 documents that the duplicate sample result comparison with the partner's sample results that all comparison criteria were less than the calculated warning limits (see Figure 35-5 below).

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. <u> </u>	Form HI	DP-PR-FS	S-703-1 F	ield D	Figure 35 uplicate Sa		ssessment I	.SA 12-(	97 (1 of 2	2)		<u> </u>	
I la matita	Procedure: HDP-PR-		al Status Sur	vey Ou	ality Control	_							
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	1			F	ORM HDP-	PR-FSS-7	03-1		<u> </u>	<u>I</u>	<u></u>		
			FIE	ELD DU	PLICATE SA	AMPLE A	SSESSMENT						
Survey Unit No.:	LSA 12-07 Survey Unit Description: Class 1 Laydown Land Area in "Area 13"												
					Field Duplica		Average	Nuclide		]		Statistic	
	Field Duplicate			Sample (pCi/g)		'g)	Activity $(\bar{\chi})$	DCGL		Warning		Exceeds Limit?	
Sample ID	Sample ID	Radionuclide	· · · · · · · · · · · · · · · · · · ·		Activity (x <sub>i</sub> )	MDC	(pCi/g)	(pCi/g)	Statistic <sup>2</sup>	Limit	Limit	(Y/N)	
L12-07-16-P-S-S-00	L12-07-16-P-S-Q-00	Ra-226	0.841	0.0717	0.85	0.0762	0.846	1.9	0.009	0.269	0.403	<u>N</u>	
L12-07-16-P-S-S-00	L12-07-16-P-S-Q-00	Tc-99 Th-232	0.204	0.22	-0.0485 0.959	0.231	0.078	25.1	NA 0.026	3.552 0.283	5.321 0.424	NA N	
L12-07-16-P-S-S-00	L12-07-16-P-S-Q-00	U-234 <sup>1</sup>	<u> </u>	· · · · ·			· · · · ·			<u> </u>	l		
L12-07-16-P-S-S-00 L12-07-16-P-S-S-00	L12-07-16-P-S-Q-00	U-234 U-235	2.249 0.116	N/A 0.343	4.952 0.268	N/A 0.185	3.601	195.4 51.6	2.703 NA	27.649	41.425	N NA	
L12-07-16-P-S-S-00	L12-07-16-P-S-Q-00	U-235 U-238	1.5	0.745	1.99	0.96	1.745	168.8	0.490	23.885	35.786	N	
	o MDC available. Int is not necessary if the $\frac{1}{240016.5} 41000000000000000000000000000000000000$	,		MDC.	-		Reviewed by:	h). Yar	L.T.reis	[W.	Ung		
Date:	11-23-16		· .				Date: 11/2	7/14			-		

Hematite Decommissionin	00 000	<i>t 09 (LSA 1</i>	-						y Areu 1.		y Onus	s 03, 04, 05, 0
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	Form H	DP-PR-FS	S-703-1 F	ield D	Figure 35 uplicate S		ssessment I	.SA 12-(	)7 (2 of 2	2)		
Hematite	Procedure: HDP-PR	FSS-703, Fina	al Status Sur	vey Qua	lity Control							
Decommissioning Project								Revis	ion: 2		Page I	of l
Survey Unit No.:	LSA 12-07			,	Survey Unit I	Description:	Class I Laydow	n Land Are	a in "Area	13"		
	Field Duplicate		Sample (p	Ci/g)	Field Duplic (pCi/		Average Activity $(\bar{\chi})$	Nuclide DCGL		Warning	Control	Statistic Exceeds Limit?
Sample ID	Sample ID	Radionuclide			Activity (x <sub>i</sub> )	MDC	(pCi/g)	(pCi/g)	Statistic <sup>2</sup>	Limit	Limit	(Y/N)
	L12-07-19-P-S-Q-00	Ra-226	0.952	0.0759	0.86	0.0582	0.906	1.9	0.092	0.269	0.403	N
	L12-07-19-P-S-Q-00	Tc-99	0.0359	0.211	0.141	0.232	0.088	25.1	NA	3.552	5.321	NA
	L12-07-19-P-S-Q-00	Th-232	0.984	0.119	0.971	0.0867	0.978	2.0	0.013	0.283	0.424	N
	L12-07-19-P-S-Q-00	U-234	5.758	N/A	6.122	N/A	5.940	195.4	0.364	27.649	41.425	N
	L12-07-19-P-S-Q-00	U-235	0.318	0.191	0.337	0.174	0.328	51.6	0.019	7.301	10.939	N
L12-07-19-P-S-S-00	L12-07-19-P-S-Q-00	U-238	1.19	0.889	1.6	· 0.78	1.395	168.8	0.410	23.885	35.786	N

Performed by: Themas Yardy Monta

11-23-16

Date:

Reviewed by: W. Clark Every W. Chan Date: 11/23/16

Quality Record

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#### 35.3 Tc-99 Hot Spot Assessment LSA 12-07

There is no historical sampling data available for this area since it was always considered a nonimpacted area prior to the storage of potential reuse soils within the LSA. As a previously unimpacted area there is no history of a Tc-99 sample result ever exceeding the Tc-99 Uniform  $DCGL_w$ , as only potential reuse soil was placed within the LSA. The highest Tc-99 sample result collected from both Final RASS and FSS was 2.42 pCi/g. Therefore there is no concern for a potential Tc-99 hot spot exceeding the  $DCGL_w$  of 25.1, and there is no reason to perform a Tc-99 hot spot assessment.

#### 36.0 ALARA EVALUATION LSA 12-07

All samples collected within LSA 12-07 were evaluated against the Uniform Stratum DCGL<sub>w</sub>. For LSA 12-07 no sample result exceeded a SOF of 1.0. The average SOF result, based on all systematically collected samples, was 0.06 for LSA 12-07. The average SOF equates to residual activity contributions from the survey unit area of 1.5 mrem/yr for LSA 12-07. Groundwater Monitoring Well data provided in FSSFR Volume 6, Chapters 2 and 3 {ML16287A528} and Chapter 4 {ML16342B552}, indicate that the groundwater dose contribution will be a fraction of the MCLs. Nevertheless, a maximum groundwater contribution assumption of 4.0 mrem/yr based upon the EPA MCLs will be added to the total estimated dose for LSA 12-07. Adding these dose contributions together, the total estimated dose for LSA 12-07 is 5.5 mrem/yr.

Since the estimated Total Effective Dose Equivalent is well below the regulatory release criterion of 25 mrem/yr, the conclusion of the ALARA evaluation is that the FSS of LSA 12-07 was successful and that there would be no discernable benefit to the health and safety of the public in attempting to further reduce the results of FSS by performing remediation of LSA 12-07.

#### 37.0 FSS PLAN DEVIATIONS LSA 12-07

#### 37.1 Remedial Actions during FSS

There was no remedial action in LSA 12-07.

#### 37.2 Adjustments to Scan MDC Calculations

Scan MDCs for LSA 12-07 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD- FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. The assumed LSA background count rate of 10,000 cpm was applied to determine the prospective Scan MDCs, and the actual mean count rate from the FSS survey was 10,110 cpm. Therefore the calculated Scan MDCs are appropriate, and no adjustments need to be made.

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# 38.0 DATA QUALITY ASSESSMENT

The DQO process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process are presented in Volume 3, Chapter 1, Section 4.0 of the FSSFR and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

# 38.1 Data Quality Assessment for LSA 12-07

The Data Quality Assessment of the survey methodology, sampling and sample analysis results, and the Quality Control sampling and analysis results to ascertain the validity of the conclusion for LSA 12-07 (see Figure 38-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-416 (*Operation of the Ludlum 2221 for Final Status Survey*).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.
- The systematic samples that were collected (on a random-start triangular grid) and the gamma scan surveys that were conducted were performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.
- All samples sent for analysis at the approved offsite laboratory (TestAmerica) were tracked on a chain of custody form in accordance with HDP-PR-QA-006, *Chain of Custody*.
- Quality Control sample results were verified to meet the acceptance criteria as specified in HDP-PR-FSS-703, *Final Status Survey Quality Control*.
- LSA 12-07 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.
- The WRS Test is not necessary when the difference between the maximum survey unit data set measurement SOF and the minimum background area measurement SOF is less than or equal to one. For LSA 12-07, no individual gross SOF result in the FSS data set exceeded the SOF of the minimum background reference area measurement by more than one using the Uniform Stratum criteria. Therefore, the WRS Test was not required for LSA 12-07. However the WRS Test was still performed for illustrative purposes. Since the test statistic, WR (1040) exceeded the critical value (860), the FSS data set passed the WRS Test and the null hypothesis was rejected. The WRS Test worksheet is presented in Appendix E.
- A biased soil sample was collected from the location of the highest gamma count rate within the SU, and the result was a 0.02 Uniform SOF.

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. •	The maximum SOF result for all surface samples within The maximum SOF result for all subsurface samples within The average SOF result for all systematically collected samp was 0.06, with an upper 95% confidence level (UCL <sub>mean</sub> 0.9	LSA 12-07 was 0.15. ples within LSA 12-07
•	No FSS sample result in LSA 12-07 exceeded a SOF of 1 Uniform Stratum criteria, therefore an EMC or supplement not required. For the same reason, no comparisons to the al multi-CSM (i.e. Surface, Root and Excavation) DCGLs were	tal investigations was ternate "Three-Layer"
	A retrospective sampling frequency evaluation was perform sufficient statistical power exists to reject the null hypothern number (8) of systematic samples actually collected with successful result of the retrospective power evaluation prese LSA 12-07 indicates that the minimum number of sample WRS Test were equal to the number of sampling location within LSA 12-07. The methodology used for the re- frequency evaluation is similar to the prospective samp performed during FSS Plan Development except that actual and statistics are used in the sample size verification. Spective standard deviation of the eight LSA surface samples (i.e., data set) are used to derive the relative shift for each LSA. and Type II errors of 0.05 and 0.10, respectively, the calc then correlated to a minimum sample size number as pro-	esis based on the total nin LSA 12-07. The ented in Table 38-1 for es required (8) for the ons actually collected etrospective sampling ble size determination al FSS sample results eifically, the mean and the WRS Test sample Given the HDP Type I ulated relative shift is

MARSSIM.

• HDP staff ensured that a visual inspection of the SU configuration and of the Isolation & Control measures were performed periodically, and confirmed that there were no instances of potential cross contamination from weather events until the FSS of all remaining areas at HDP were completed.

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# Table 38-1Retrospective Sample Size Verification for LSA 12-07

N/2 Value Verification				
lsotope(s)	SOF (Ra/Tc/Th/Iso U)			
St. Dev.	0.04			
DCGL <sub>SOF</sub>	1			
LBGR (Mean)	0.06			
Shift	0.94			
Relative Shift (Δ/σ)	23.44			
MARSSIM Table 5.1 (Pr)	1.000000			
Ν	12			
N + 20%	14.4			
N/2	8			
FSS N/2	8			
Verification Check	SUFFICIENT MEASUREME			

"N/2" Corresponds to the number of survey unit measurement locations required for the WRS Test

MARSSIM Table 5.1					
Δ/σ	Pr				
0.1	0.528182				
0.2	0.556223				
0.3	0.583985				
0.4	0.611335				
0.5	0.638143				
0.6	0.664290				
0.7	0.689665				
0.8	0.714167				
0.9	0.737710				
1.0	0.760217				
1.1	0.781627				
1.2	0.801892				
1.3	0.820978				
1.4	0.838864				
1.5	0.855541				
1.6	0.871014				
1.7	0.885299				
1.8	0.898420				
1.9	0.910413				
2.0	0.921319				
2.25	0.944167				
2.5	0.961428				
2.75	0.974067				
3.0	0.983039				
3.5	0.993329				
4.0	0.997658				
4.01	1.000000				

#### MARSSIM Table 5.2, $\alpha = 0.05$ , $\beta = 0.10$

aß

α (or β)	$Z_{1-\alpha}$ (or $Z_{1-\beta}$ )
0.005	2.576
0.01	2.326
0.015	2.241
0.025	1.960
0.05	1.645
0.10	1.282
0.15	1.036
0.2	0.842
0.25	0.674
0.30	0.524

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APPENDIX G-1         FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST         Survey Area:       LSA 12       Description:       Laydown Area, Plant Soils SEA         Survey Unit:       07       Description:       Class 1 Laydown Land Area in "Area 13"         1.       Have all measurements and/or analysis results that will be subjected to data analysis for FSS been individually reviewed and validated in accordance with Section 8.1 of this procedure?       Yes No         2.       Have all systematic measurements and/or samples been taken or acquired at the locations specified in the FSSP and the FSS Sample Instructions?       Yes No       No         3.       Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?       Yes No       No         4.       Have all biased measurements and/or samples been taken or acquired at the location specified in the FSSP & the FSS Sample Instructions?       Yes No       No         5.       Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?       Yes No       No       NA         6.       Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?       Yes No       No         7.       Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were th	1 of 2
<ul> <li>Survey Unit: 07 Description: Class 1 Laydown Land Area in "Area 13"</li> <li>1. Have all measurements and/or analysis results that will be subjected to data analysis for FSS been individually reviewed and validated in accordance with Section 8.1 of this procedure?</li> <li>2. Have all systematic measurements and/or samples been taken or acquired at the locations specified in the FSSP and the FSS Sample Instructions?</li> <li>3. Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?</li> <li>3. Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?</li> <li>4. Have all biased measurements and/or samples been taken or acquired at the location specified in the FSSP &amp; the FSS Sample Instructions?</li> <li>5. Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?</li> <li>6. Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?</li> <li>7. Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?</li> <li>8. Were the instruments successfully response-checked before use and, Yan Mo Line Area in "Area 13"</li> </ul>	
<ul> <li>Survey Unit: 07 Description: Class 1 Laydown Land Area in "Area 13"</li> <li>1. Have all measurements and/or analysis results that will be subjected to data analysis for FSS been individually reviewed and validated in accordance with Section 8.1 of this procedure?</li> <li>2. Have all systematic measurements and/or samples been taken or acquired at the locations specified in the FSSP and the FSS Sample Instructions?</li> <li>3. Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?</li> <li>3. Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?</li> <li>4. Have all biased measurements and/or samples been taken or acquired at the location specified in the FSSP &amp; the FSS Sample Instructions?</li> <li>5. Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?</li> <li>6. Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?</li> <li>7. Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?</li> <li>8. Were the instruments successfully response-checked before use and, Yan Mo</li> </ul>	
<ul> <li>to data analysis for FSS been individually reviewed and validated in accordance with Section 8.1 of this procedure?</li> <li>Have all systematic measurements and/or samples been taken or acquired at the locations specified in the FSSP and the FSS Sample Instructions?</li> <li>Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?</li> <li>Have all biased measurements and/or samples been taken or acquired at the location specified in the FSSP &amp; the FSS Sample Instructions?</li> <li>Have all biased measurements and/or samples been taken or acquired at the location specified in the FSSP &amp; the FSS Sample Instructions?</li> <li>Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?</li> <li>Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?</li> <li>Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?</li> <li>Were the instruments successfully response-checked before use and, var No □</li> </ul>	
<ul> <li>acquired at the locations specified in the FSSP and the FSS Sample Instructions?</li> <li>Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?</li> <li>Have all biased measurements and/or samples been taken or acquired at the locations specified in the FSSP &amp; the FSS Sample Instructions?</li> <li>Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?</li> <li>Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?</li> <li>Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?</li> <li>Were the instruments successfully response-checked before use and, Yes Xes Xes</li> </ul>	
<ul> <li>required in the FSSP and the FSS Sample Instructions?</li> <li>Have all biased measurements and/or samples been taken or acquired at the locations specified in the FSSP &amp; the FSS Sample Instructions?</li> <li>Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?</li> <li>Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?</li> <li>Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?</li> <li>Were the instruments successfully response-checked before use and, Yes ∑ No □</li> </ul>	
<ul> <li>at the locations specified in the FSSP &amp; the FSS Sample Instructions?</li> <li>Fes X INO INA</li> <li>Fes X INO INA</li> <li>Fes X INO INA</li> <li>Fes X INO INA</li> <li>INA INA</li> <li>Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?</li> <li>Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?</li> <li>Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?</li> <li>Were the instruments successfully response-checked before use and, Yes X INO INA</li> </ul>	
<ul> <li>acquired at each location designated as a QC sample?</li> <li>6. Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?</li> <li>7. Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?</li> <li>8. Were the instruments successfully response-checked before use and, Ver ∑ No □</li> </ul>	A 🗌
<ul> <li>capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?</li> <li>7. Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?</li> <li>8. Were the instruments successfully response-checked before use and, Ver No □</li> </ul>	A 🗌
<ul> <li>analyze data, current at the time of use and were those calibrations Yes ∑ No □</li> <li>performed using a NIST traceable source?</li> <li>8. Were the instruments successfully response-checked before use and, Yes ∑ No □</li> </ul>	
where required, after use on the day the data was measured?	
9. Do the samples match those identified on the chain of custody? Yes $\boxtimes$ No $\square$ NA	A 🗌
10. Do the QC Sample Results meet the acceptance criteria as specified in HDP-PR-FSS-703, Final Status Survey Quality Control?Yes ⊠ No □	
11. Are all Laboratory QC parameters within acceptable limits?Yes $\boxtimes$ No $\square$	
If "No" was the response to any of the questions above, then document the discrepancy as well corrective actions that were taken to resolve the discrepancy.	l as any
Comments: N/A	

Quality Record

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commissioning Project					Revision: 10	Appendix G-1, Page 2 of 2
ETNIA Y		-	APPENDIX G-1	CTIVES DEX		
FINAL	51A1 US SURV	VELDATA	QUALITY OBJH	ECTIVES REV	IEW CHECK	.1.151
	LSA 12		Description: L			
Survey Unit:	07		<b>Description:</b> <u>C</u>	lass I Laydowi	i Land Area m	Alea 15
Discrepancy:	N/A					
· · · · · · · · · · · · · · · · · · ·						
·			<u></u>			
Corrective Acti	ons Taken: <u>N/</u>	/A				
	<u></u>					
	·····					
						·
11. Have the c	corrective action	as resolved the	discrepancy with	the data?	_	
	', then forward th					
12. The follow	wing questions w		ed by the RSO.			
12. The follow		viii de answere				
	•		", then is the affe	cted data	Yes 🗌 N	D INA
a. If the a still val b. If "No"	lid? ', then are the ex	on 11 was "No cisting valid m	-	amples		> □ NA X > □ NA X
a. If the a still val b. If "No' sufficie c. If "No'	lid? ', then are the ex ent to demonstrat	on 11 was "No cisting valid m te compliance acquisition or	", then is the affe easurements or s for the survey un f additional measu	amples .it?	Yes 🗌 N	
<ul> <li>a. If the a still val</li> <li>b. If "No' sufficie</li> <li>c. If "No' demonstration</li> </ul>	lid? . then are the ex ent to demonstrat ., then direct the	on 11 was "No cisting valid m te compliance acquisition or	", then is the affe easurements or s for the survey un f additional measu	amples .it?	Yes 🗌 N	
<ul> <li>a. If the a still val</li> <li>b. If "No' sufficie</li> <li>c. If "No' demonstration</li> </ul>	lid? . then are the ex ent to demonstrat . then direct the strate compliance (HP Staff):	on 11 was "No cisting valid m te compliance acquisition or	", then is the affe easurements or s for the survey un f additional measu	amples .it?	Yes 🗌 N	
<ul> <li>a. If the a still val</li> <li>b. If "No' sufficie</li> <li>c. If "No' demons</li> </ul>	lid? . then are the ex ent to demonstrat . then direct the strate compliance (HP Staff):	on 11 was "No cisting valid m te compliance acquisition or	", then is the affe easurements or s for the survey un f additional measu	amples .it?	Yes 🗌 N	

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#### **39.0 CONCLUSION LSA 12-07**

An adequate quantity and quality of radiological surveys and samples, as well as the corresponding laboratory analysis has been performed, evaluated and documented to demonstrate that the dose associated with all sources within SU LSA 12-07 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402.

LSA 12-07 SOF and Dose Summation							
	AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	BURIED PIPING	REUSE SOIL	TOTAL	
SOF	0.06	N/A	0.16	N/A	N/A	0.22	
DOSE	1.5 mrem/year	N/A	4.0 mrem/year	N/A	N/A	5.5 mrem/year	

Table 39-1LSA 12-07 SOF and Dose Summation

Hematite	FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12,				
Decommissioning	Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)				
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#### 40.0 FINAL STATUS SURVEY DESIGN LSA 12-08

This section of the report describes the method for determining the number of samples required for the FSS of LSA 12-08 as well as summarizing the applicable requirements of the FSS Plan. These include the  $DCGL_W$ , scan survey coverage, and IAL. The radiological instrumentation used in the FSS of LSA 12-08 and the detection sensitivities are also discussed.

#### 40.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 12-08 were driven by the type (Open Land) and Class (Class 1) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development*, November 2015.

#### 40.1.1 Surrogate Evaluation Areas

A discussion of Surrogate Evaluation Areas is given in the FSSFR Volume 3, Chapter 1, Section 5.0, *Final Status Survey Design*.

#### 40.1.2 DCGL<sub>w</sub>

During the FSS design process a review was performed of the RASS data for LSA 12-08. The RASS data was used as confirmation that no known areas of residual radioactivity remained within the survey areas that exceeded the Uniform Stratum DCGL<sub>w</sub>. Therefore the Uniform Stratum DCGL<sub>w</sub> was selected for use in demonstrating compliance with the release criteria.

#### 40.1.3 GWS Coverage

As a Class 1 SU, LSA 12-08 was required to undergo a 100% GWS.

#### 40.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 12-08 was the Ludlum 44-10 2" x 2" NaI detectors, coupled to a Ludlum 2221 scaler-ratemeter.

#### 40.1.5 Scan Minimum Detectable Concentration

Scan MDCs for LSA 12-08 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD- FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. As background levels were approximately 10,000 cpm within LSA 12-08, the scan MDC calculation for total uranium given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.2.6.d, was applied:

Scan MDC (total uranium) = 
$$\frac{1}{\left(\left(\frac{f_{U-234}}{3659 \ pCi/g}\right) + \left(\frac{f_{U-235}}{2.32 \ pCi/g}\right) + \left(\frac{f_{U-238}}{30.6 \ pCi/g}\right)\right)}$$

Equation 40-1

To determine isotopic Uranium fractions HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* assumes that the average LSA enrichment is 4% or less. Based on the

Hematite	FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12,			
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systematically collected RASS samples in LSA 12-08, the average enrichment for the SU was 2.96%. All other Scan MDC parameters agreed upon between Westinghouse and the NRC were applied (e.g. use of a 2 in air gap, scan rate of 1 ft/sec, 0.75 surveyor efficiency), therefore no subsequent changes to the calculated Scan MDCs need to be made.

Prospectively calculated Scan MDCs for 2" x 2" NaI detectors that were used in LSA 12-08 are shown below:

Table 40-1Scan MDCs for 2" x 2" NaI detector, 10,000 cpm background: LSA 12-08

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 12-08	40.9	46.6	0.87	2.8	1.21	3.0

\*DCGL<sub>w</sub> includes background concentrations of 0.9 pCi/g for Ra-226 (no ingrowth) and 1.0 pCi/g for Th-232. DCGLw values are based on the Uniform Stratum release criteria.

The values in Table 40-1 reflect those presented in the FSS Plans prepared for the SU prior to FSS.

#### **40.1.6 Investigation Action Level**

FSSFR Volume 3, Chapter 1, Section 6.1.3, *Investigation Action Level (IAL)*, provides a discussion in regards to the IAL. The basis of the IAL is detailed in HDP memorandum, HEM-15-MEMO-021 "Evaluation of the Scan IAL for Class 1 areas at the Westinghouse Hematite Site". The IAL used during the GWS of LSA 12-08 was established at 4,000 ncpm.

#### 40.1.7 LSA 12-08 FSS Design Summary

The FSS Plans for LSA 12-08 can be found in Appendix M. Table 40-2 presents an overall FSS design and implementation summary for LSA 12-08.

Hematite	FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12,				
Decommissioning	Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)				
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#### **Table 40-2**

FSS Design Summary for LSA 12-08

Gamma Walkover Survey (GWS):					
Scan Coverage	100% exposed soil and rock				
Scan MDC	40.9 pCi/g total Uranium (based on a 10,000 cpm background); 0.87 pCi/g Th-232; 1.21 pCi/g Ra-226*				
Investigation Action Level (IAL)	4,000 net cpm **				
Systematic Sampling Locations:					

	1 0		
	Depth	Number of Sample	
	0-15 cm (Surface)	8	
-	15 cm – 1.5 m (Root)	8	Т [
	> 1.5m (Excavation)	8	1

These samples will be taken on a random-start systematic grid.

Comments

#### **Biased Survey/Sampling Locations:**

Biased samples may be collected during GWS at the discretion of the HP Technician, after statistical analysis of the survey data, or at the direction of the RSO or Radiological Engineering.

#### **Sidewall Sampling Locations:**

A minimum of one (1) discretionary sidewall sample will be collected based on the following definition of "sidewall": sidewall candidates for sampling must be vertical or near vertical (>  $45^{\circ}$  angle) and at least 12" in height.

#### Instrumentation:

Ludlum 2221 with 44-10 (2x2 NaI) detector; with<br/>collimation for investigationsUsed for GWS and to obtain static count rates at<br/>biased measurement locations.

\*Values based on information provided in HDP-TBD-FSS-002, "Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS). The Scan MDC for total Uranium reflects a conservative assumption of 4% enrichment. The actual RASS enrichment (2.0%) would result in Scan MDC values slightly less than those calculated for FSS planning purposes.

\*\*IAL is the net count per minute (ncpm) equivalent of an activity concentration less than the Uniform Stratum DCGLw derived from the technical bases presented in HEM-MEMO-15-021 and HDP-TBD-FSS-003 "*Modeling and Calculation of Investigative Action Levels for Final Status Soil Survey Units*", Westinghouse, March 2015.

#### 41.0 FINAL STATUS SURVEY IMPLEMENTATION LSA 12-08

FSS was performed in accordance with procedure HDP-PR-FSS-711, Final Status Surveys and Sampling of Soil and Sediment.

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Decommissioning	Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)				
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#### 41.1 Gamma Walkover Survey

# 41.1.1 Instrumentation

The selected instrumentation to perform the GWS in LSA 12-08 was a 2" x 2" NaI detector in combination with a Ludlum 2221 rate meter. Each NaI instrumentation set was interfaced with a Trimble DGPS (Digital Global Positioning System) and handheld data logger.

Prior to the first field use of the GWS instrumentation, initial set-ups were performed. Also, daily pre- and post-use source checks were performed for each day that GWS was performed within the SU. Initial set-ups, daily source checks, and control charting were performed according to the requirements of HDP-PR-HP-416, *Operation of the Ludlum 2221 for Final Status Survey*.

# 41.1.2 GWS Performance

All GWS measurements on the excavation floor and sidewalls collected with the NaI detector(s) were connected to a Trimble DGPS and with a hand-held data logger. The logging frequency in the survey unit was 1 GWS measurement per second. Each gross gamma measurement is correlated to a set of coordinates based on the Missouri East State Plane, NAD 1983.

The GWS requirements involved moving the NaI detector in a side-to-side fashion no faster than 1 foot per second while holding the probe as close as possible to the excavation surface (nominally 1", but not to exceed 3"). At the same time, the technician was required to slowly advance, causing the detector to trace out a serpentine path over the excavation surface.

FSS Technicians performing GWS in LSA 12-08 used the 4,000 ncpm IAL as a field guide to know when to slow or pause the GWS for more deliberate investigation. If during the GWS, audible count rates noticeably increase above the general area average (i.e., > minimum detectable count rate), FSS Technicians were required to pause momentarily and observe count rates. If sustained count rates approached the IAL, further focused investigation was conducted within the locally elevated area.

To use the IAL effectively, FSS Technicians first determined the local background count rate before starting the GWS. Although the ambient gamma level may vary across the SU due to excavation geometry and relative distance from contaminated materials in nearby remedial excavations, the average background rate (measured at waist level) within the LSA ranged between 10,000 and 11,000 gcpm. Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 14,000 to 15,000 gcpm, FSS Technicians slowed or paused the GWS for more careful investigation of the small areas of elevated activity before deciding if "flagging" a point for potential biased sampling was warranted.

Hard to reach areas, and non-typical areas were surveyed manually as necessary in order to assess the potential for an area of elevated residual activity over 100% of the exposed ground surface.

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Decommissioning	Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)			
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After the GWS survey was complete, the GPS/GWS data was reviewed by Radiological Engineering and the Health Physics Technician performing the survey to determine if possible areas of elevated residual activity remained within the SU that required biased sample investigation. Areas that were flagged by the HP Technician were considered, as well as a statistical evaluation of the GWS data set. The statistical evaluation determined the mean count rate and standard deviation associated with the GWS and then could be used to identify any areas that exceeded 3 standard deviations above the mean. The number of biased samples to be collected and the locations are based on flagged locations exceeding the IAL, the statistical evaluation of the GWS data set, and the professional judgment of Radiological Engineering.

#### 41.2 Soil Sampling

#### 41.2.1 Systematic Soil Sampling Summary

Table 41-1 provides a summary of systematic sampling by stratum for LSA 12-08.

	SU Area,				
LSA	blanar ( $m^2$ )	Surface	Root	Deep (Excavation)	QC
12-08	1,995	8	8	8*	2

 Table 41-1

 Systematic Sampling Summary by Stratum for LSA 12-08

\*Excavation samples were collected and archived, analysis only required if a overlying Root sample exceeds a 0.5 SOF

#### 41.2.2 Systematic Sampling LSA 12-08

Within LSA 12-08, there were 8 systematic locations in which the surface stratum (0 - 15 cm) was sampled in the SU. The underlying root stratum was sampled at all 8 locations. Excavation stratum samples were collected and archived, but were not required to be analyzed since no root stratum sample exceeded a 0.5 Uniform SOF.

Given a planar area of  $1,995 \text{ m}^2$  for LSA 12-08 and an eight - point systematic triangular grid, the point-to-point distance within each row was 16.9 m with spacing of 14.6 m between each of the parallel grid rows within the SU.

While there were eight (8) systematic locations on the LSA 12-08 sampling grid, a total of eighteen (18) samples were collected and analyzed at these locations, including:

- Eight (8) samples collected and analyzed within the surface stratum
- Eight (8) samples collected and analyzed within the root stratum
- Zero (0) samples analyzed within the excavation, or "deep" stratum
- Two (2) QC field replicate

Figure 41-1 presents the map of the eight systematic sample locations which were sampled within LSA 12-08. The inset table notes the location coordinates (Missouri East, NAD 1983) and collection intervals for each systematic location.

Hematite Decommissioning	FSSFR Volume 3, Chapter 9: Survey Area Release Record for 08, and 09 (LSA 12-03 through 12-09)	Land Survey Area 12, Survey Units 03, 04, 05, 0
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	Figure 41-1 LSA 12-08 Systematic Soil Sample Loca	tions
Hematite I Sample ID	Start     End     Northing     Easting       Depth     Depth     (feet)	
L12-08-01-P-S-S-0 L12-08-02-P-R-S-0 L12-08-03-P-E-S-0 L12-08-04-P-S-S-0 L12-08-05-P-R-S-0 L12-08-05-P-E-S-0 L12-08-06-P-E-S-0 L12-08-08-P-R-S-0	0         6         865719         827933           6         59         865719         827933           59         65         865719         827933           0         6         865719         827933           0         6         865719         827933           0         6         865719         827989           6         59         865719         827989           59         65         865719         827989           0         6         865671         827961           0         6         865671         827961           112-08         6         59         865671	12-08-11-P-R-S-00 L12-08-12-P-E-S-00 13-P-S-S-00 14-P-R-S-00 12-08-16-P-S-S-00 14-P-R-S-00 12-08-17-P-R-S-00 15-P-E-S-00 L12-08-18-P-E-S-00
L12 08-09-P-E-S-0 L12-08-10-P-S-S-0 L12-08-11-P-R-S-0 L12-08-12-P-E-S-0 L12-08-13-P-S-S-0 L12-08-13-P-S-S-0 L12-08-14-P-R-S-0 L12-08-15-P-E-S-0 L12-08-16-P-S-S-0	59         65         8656/1         82/961           0         6         865671         828017           6         59         865671         828017           0         6         865671         828017           0         6         865671         828017           0         6         865623         827989           6         59         865623         827989           59         65         865623         827989           0         6         865623         827989           0         6         865623         828044	L12-08-17-P-R-Q-00 08-19-P-S-S-00 L12-08-22-P-S-S-00 08-20-P-R-S-00 L12-08-23-P-R-S-00 08-21-P-E-S-00 L12-08-24-P-E-S-00
L12-08-17-P-R-S-0 L12-08-18-P-E-S-0 L12-08-19-P-S-S-0 L12-08-20-P-R-S-0 L12-08-21-P-E-S-0 L12-08-22-P-S-S-0 L12-08-23-P-R-S-0 L12-08-24-P-E-S-0	59         65         865623         828044           0         6         865575         828017           6         59         865575         828017           59         65         865575         828017           0         6         865575         828017           0         6         865575         828072           6         59         865575         828072           59         65         865575         828072           59         65         865575         828072	60 99 120 Feet
L12-08-05-P-R-Q-0		

	FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12, Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)		
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Figure 41-2 below presents a tabular listing of all FSS samples collected within LSA 12-08 with associated IDs, sample types, collection intervals, coordinates, and notes.

Ilenstite		Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development						
Hematite Decommission Project					Revision: 10	Appendix P-4, Page 1 of		
APPENDIX P-4 FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES								
Survey Area:	LSA	12		Description:		Laydown Are	ea, Plant Soils SEA	
Survey Unit:	08	8	-	Description:		Class 1 Lavdown	Land Area in "Area 13"	
-		-	-					
Survey Type:	FS	5	-1	Classificatio	n:	(	Class 1	
Measurement or Sample ID	Surface or CSM	Туре	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes	
L12-08-01-P-S-S-00	Uniform	S	431.2	430.7	865719	827933	Surface 6-inch grab	
L12-08-02-P-R-S-00	Uniform	S	430.7	426.3	865719	827933	Root 59-inch composite	
L12-08-04-P-S-S-00	Uniform	S	430.6	430.1	865719	827989	Surface 6-inch grab	
L12-08-05-P-R-S-00	Uniform	S	430.1	425.7	865719	827989	Root 59-inch composite	
L12-08-07-P-S-S-00	Uniform	S	430.8	430.3	865671	827961	Surface 6-inch grab	
L12-08-08-P-R-S-00	Uniform	S	430.3	425.9	865671	827961	Root 59-inch composite	
L12-08-10-P-S-S-00	Uniform	S	430.0	429.5	865671	828017	Surface 6-inch grab	
L12-08-11-P-R-S-00	Uniform	S	429.5	425.1	865671	828017	Root 59-inch composite	
L12-08-13-P-S-S-00	Uniform	S	430.3	429.8	865623	827989	Surface 6-inch grab	
L12-08-14-P-R-S-00	Uniform	S	429.8	425.4	865623	827989	Root 59-inch composite	
L12-08-16-P-S-S-00	Uniform	S	429.9	429.4	865623	828044	Surface 6-inch grab	
L12-08-17-P-R-S-00	Uniform	S	429.4	425.0	865623	828044	Root 59-inch composite	
L12-08-19-P-S-S-00	Uniform	S	429.9	429.4	865575	828017	Surface 6-inch grab	
L12-08-20-P-R-S-00	Uniform	S	429.4	425.0	865575	828017	Root 59-inch composite	
L12-08-22-P-S-S-00	Uniform	S	429.6	429.1	865575	828072	Surface 6-inch grab	
L12-08-23-P-R-S-00	Uniform	S	429.1	424.7	865575	828072	Root 59-inch composite	
L12-08-05-P-R-Q-00	Uniform	Q	430.1	425.7	865719	827989	Root 59-inch composite	
L12-08-17-P-R-Q-00	Uniform	Q	429.4	425.0	865623	828044	Root 59-inch composite	
L12-08-25-P-S-B-00	Uniform	В	429.0	428.5	865529.1	828060.7	Biased 6-inch grab	

# Figure 41-2 FSS Sample Locations and Coordinates for LSA 12-08

Green shaded samples are the samples at each sample location, for use in WRS Test.

\*Elevations are in feet above mean sea level.

\*\* Missouri - East State Plane Coordinates [North American Datum (NAD) 1983]

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R

CSM: Three-Layer (Surface-Root-Excavation) or Uniform DCGLs used

Type: Systematic = S, Biased = B; QC =Q; Investigation = I

Quality Record

Hematite	FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12,				
Decommissioning	Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)				
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#### 41.3 Biased Soil Sampling

As discussed in FSSFR Volume 3, Chapter 1, Section 6.1.3, there are three key methods for identifying areas for biased soil sampling, the IAL, the Z-score of the FSS GWS, and the professional judgment of the HP Staff. For LSA 12-08 one (1) biased sample location was selected within the SU based on the evaluation of the GWS survey data and HP Technician professional judgment. These biased locations represented the two maximum GWS measurements encountered within the SU. Biased samples are collected at the prescribed location to a depth of 6 inches below the exposed ground surface.

# 41.4 Judgmental/Sidewall Sampling for Tc-99

As an un-excavated SU, no Tc-99 sidewall sampling was necessary for LSA 12-08.

# 41.5 Quality Control Soil Sampling

Two QC field duplicate sample point were randomly selected and collected at systematic locations L12-08-05 and L12-08-17 for LSA 12-08.

# 42.0 FINAL STATUS SURVEY RESULTS LSA 12-08

# 42.1 Gamma Walkover Survey

Post-processed GPS coordinate data is accurate to within  $\pm 0.1$  m for the handheld GPS models used during the GWS. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same GPS location during the walkover, the most elevated radiological measurements are plotted "on top" (e.g. if any sidewalls featured more elevated readings than the floor directly below, the sidewall radiological measurements would overlie the lower floor readings).

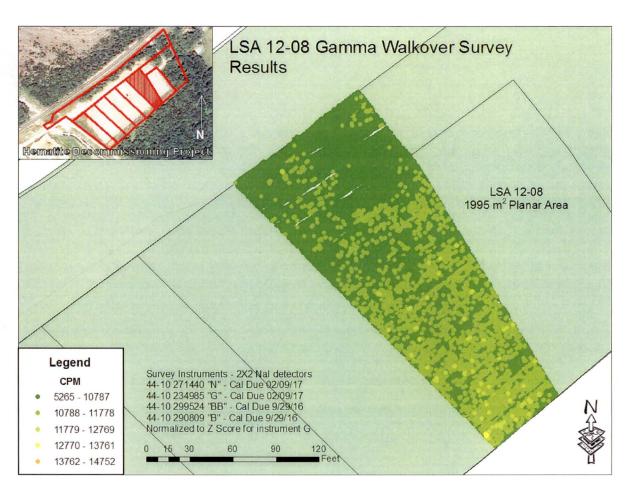
GWS measurements were collected in LSA 12-08 between May 6, 2016, and May 15, 2016.

# 42.1.1 GWS Results for LSA 12-08

For LSA 12-08, GWS count rates ranged between 5,265 gcpm and 13,902 gcpm, with a mean count rate of 9,769 gcpm. The median count rate was 9,584 gcpm and the standard deviation was 991 cpm. Figure 42-1 below presents a map of the complete GWS data set.

Hematite Decommissioning Project	FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12, Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)					
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Figure 42-1 Colorimetric GWS Plot for LSA 12-08

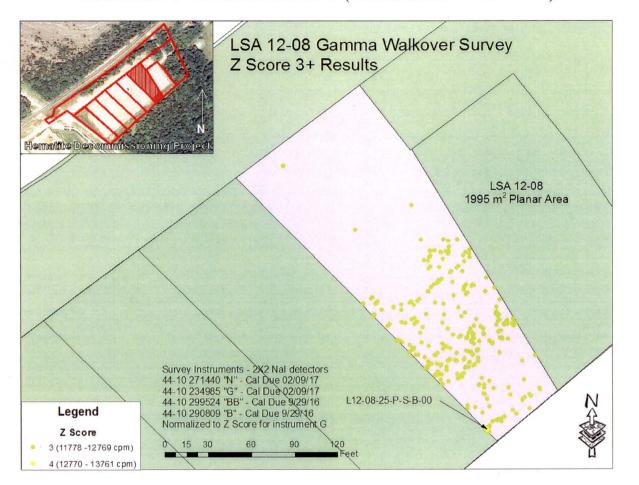


An evaluation of the entire GWS data set was performed to evaluate those small areas of elevated activity which exceeded three (3) standard deviations above the GWS mean measurement, (i.e., "+3 Z-score"). One locations, L12-08-25, was selected for biased sample collection. The biased location represented the maximum GWS measurements encountered within the SU.

Figure 42-2 below presents a map of the +3 Z-score GWS measurements within LSA 12-08, including the selected biased sampling locations (ID: L12-08-25-P-S-B-00).

Hematite	FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12,					
Decommissioning	Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)					
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#### Figure 42-2 Colorimetric GWS Plot for LSA 12-08 (Measurements > Z-score of 3)



All GWS data collected in LSA 12-08 was datalogged and post-processed in Graphical Information Software (GIS).

#### 42.1.2 GWS Coverage Results LSA 12-08

FSSFR Volume 3, Chapter 1, Section 6.1.4, *Exposed Surfaces versus Accessible Surfaces*, provides a discussion and the criteria for evaluating the GWS coverage of a SU during FSS. Although 100% of accessible areas underwent GWS, the post survey processing of the GPS data indicated that the GWS covered 99.3% of the SU (see Table 42-1). As the evaluation indicates that the GPS coverage exceeded 95% with no readings approaching or exceeding the IAL of 4,000 net cpm in the vicinity of any apparent GPS coverage gaps, the GWS coverage for the SU has been evaluated to meet the intent of the "100% GWS coverage" requirement.

Hematite	FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12,				
Decommissioning	Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)				
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# Table 42-1 GWS Gap Analysis LSA 12-08

	Total SU	GWS Gap	Gap	GWS	MARSSIM
	Pixels	Pixels	Percentage	Coverage	Class
LSA 12-08	155,416	1082	0.7	99.3	1

#### 42.2 Soil Sample Results LSA 12-08

#### 42.2.1 Surface Soil Sample Results LSA 12-08

There were eight systematic samples collected within the surface stratum (0 - 15 cm) of LSA 12-08. Additionally one biased sample was collected from the topmost layer of soil. The maximum Uniform SOF result for the "topmost" samples was 0.23.

Appendix F presents the analytical results and associated statistics for all FSS surface samples collected within LSA 12-08.

#### 42.2.2 Subsurface Soil Sample Results LSA 12-08

There were eight systematic locations within LSA 12-08 where root stratum composite sampling was necessary. The root stratum zone is between 0.15 and 1.50 m below final grade surface. At each of the eight root stratum composite sampling locations, the top six inches (1.50 - 1.65 m below final grade surface) of the underlying excavation stratum was also collected and archived, however these excavation samples were not required to be analyzed as no overlying root stratum sample exceeded a 0.5 SOF. The maximum SOF result of the subsurface samples collected in LSA 12-08 was 0.15.

#### 42.2.3 WRS Evaluation

Per Step 7.8.3 of HDP-PR-FSS-721 *Final Status Survey Data Evaluation*, the Wilcoxon Rank Sum (WRS) statistical test was not required for LSA 12-08 since the difference between the maximum SU data set gross SOF and the minimum background area SOF was less than one using the Uniform Stratum criteria. However, for illustrative purposes, the WRS evaluation was still performed for LSA 12-08. All systematically collected samples regardless of depth are used to perform the WRS Test, however biased and QC sample results are not utilized in the WRS Test. The 16 systematically collected samples in LSA 12-08 were ranked against the adjusted activity concentrations of the 32 samples collected within the Background Reference Area. The SU passed the WRS Test since the ranked sum of the reference area ranks, or test statistic  $W_{R}$ , (1040) was greater than the critical value (860) for the test. As such, the null hypothesis that the SU average concentration is greater than the DCGL<sub>W</sub> was rejected. The WRS evaluation is also included in Appendix F.

# 42.2.4 Graphical Data Review LSA 12-08

Table 42-2 below presents summary results for the all systematically collected samples (includes surface, and root, but not biased or QC samples) collected within LSA 12-08, and the associated

Hematite Decommissioning Project	FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12, Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)				
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SOF when compared to the Uniform Stratum  $DCGL_ws$ . The arithmetic average concentration resulted in a SOF of 0.08.

Statistic	Ra-226 DCGL = 1.9 BKG = 1.07 (pCi/g)	Tc-99 DCGL = 25.1 (pCi/g)	Th-232 DCGL = 2.0 BKG = 1.0 (pCi/g)	U-234 DCGL=195.4 (pCi/g)	U-235 DCGL=51.6 (pCi/g)	U-238 DCGL=168.8 (pCi/g)	Sample SOF (Uniform DCGL)
Average	0.013	0.269	0.071	3.594	0.172	1.149	0.08
Minimum	0.00 ( <bkg)< td=""><td>0.00 (NEG)</td><td>0.00 (<bkg)< td=""><td>0.799</td><td>-0.148</td><td>0.589</td><td>0.01</td></bkg)<></td></bkg)<>	0.00 (NEG)	0.00 ( <bkg)< td=""><td>0.799</td><td>-0.148</td><td>0.589</td><td>0.01</td></bkg)<>	0.799	-0.148	0.589	0.01
Maximum	0.100	1.170	0.200	8.552	0.457	1.830	0.23

Table 42-2
LSA 12-08 FSS Sample Data Summary and Calculated SOF Values (Systematic)

Notes:

1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.

2. Average SOF for data set calculated using average radionuclide concentrations.

3. U-234 values are inferred from the U-235/U-238 ratio.

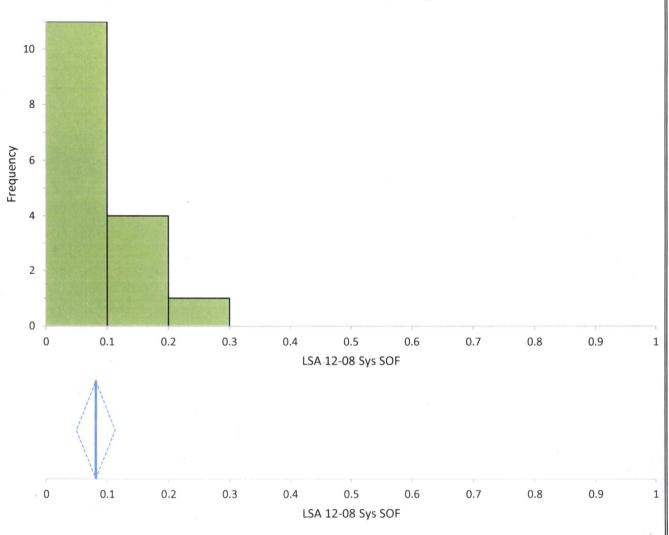
Section 8.2.2.2 of MARSSIM recommends a graphical review of FSS analytical data, to include at a minimum, a posting plot and a histogram. A frequency plot, or histogram, is a useful tool for examining the general shape of a data distribution. This plot is a bar chart of the number of data points within a certain range of values. The frequency plot will reveal any obvious departures from symmetry, such as skewness or bimodality (two peaks), in the data distribution for the survey unit. The presence of two peaks in the survey unit frequency plot may indicate the existence of isolated areas of residual radioactivity.

Figure 42-3 presents the overall statistical metrics for the SOF parameter for the 16 systematically collected samples from LSA 12-08. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 12-08. The middle graph presents the mean SOF (0.08 as indicated by the blue vertical line) of the sample population and the 95% confidence interval of the mean SOF represented by the blue diamond which is 0.05 to 0.11. The 97.87% confidence interval based on the median (0.07) of the sample results is 0.03 to 0.13. The bottom two charts present the various statistical metrics of the LSA 12-08 SOF data set, including the mean, median, standard deviation, minimum, maximum, confidence intervals, etc.

Figure 42-3 exhibits no unusual symmetry or bimodality concerns for the LSA 12-08 data associated with the systematically collected measurement locations.

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# Figure 42-3 Graphic Statistical Summary for LSA 12-08 (SOF parameter)



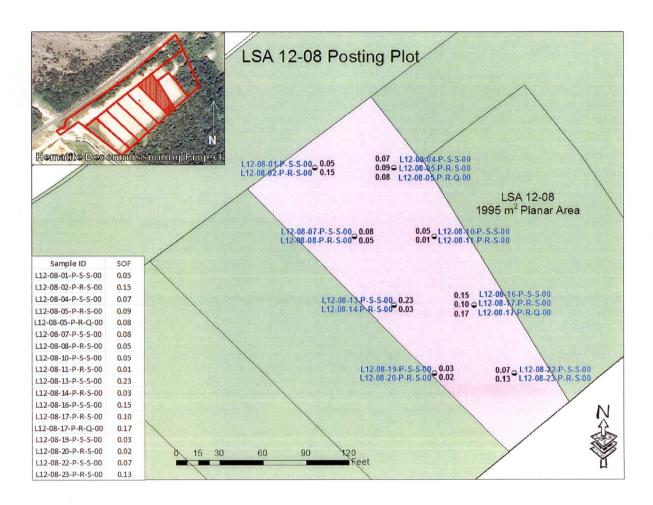
N 16

	Mean	95%	% CI	Mean SE	SD	Variance	Skewness	Kurtosis
LSA 12-08 Sys SOF	0.08	0.05	to 0.11	0.015	0.06	0.00	1.2	1.37
		1st				3rd		
	Minimum	quartile	Median	97.87	7% CI	quartile	Maximum	IQR
LSA 12-08 Sys SOF	0.01	0.04	0.07	0.03	to 0.13	0.12	0.2	0.08

Hematite	FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12,				
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A posting plot is simply a map of the survey unit with the data values (in this case the SOF values for each systematically collected sample) entered at the measurement locations. This potentially reveals heterogeneities in the data – especially possible patches of elevated residual radioactivity. The posting plot for LSA 12-08 is presented below in Figure 42-4. Figure 42-4 shows no unusual patterns in the data.

Figure 42-4 Posting Plot for LSA 12-08 Systematic Measurement Locations



Appendix F to this report presents the complete analytical data set (in Microsoft Excel format) used to derive the summary statistics presented in Table 42-2, Figure 42-3, and Figure 42-4 above. A summary of the analytical data is presented in Table 42-3 below. Appendix T to this report presents the TestAmerica Analytical Laboratory soil sample reports.

Hematite Decommissioning Project

FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12, Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)

Table 42-3

Revision: 1

Final Status Survey Analytical Data: LSA 12-08																																	
		) Ú													TestA	merica Ar	nalytica	al Results	6														
₽	Depth (ft)	ias, <b>Q</b> (														T.K																	
Sample ID		Type (Systematic, Bi	Result	Uncertainty	Ra-2 O Q	Qualifier	Net Result*	Corrected Result	Result	Corrected Result	0.000 000 000 000 000 000 000 000 000 0	MDC	Qualifier	Result	Uncertainty	U U U	Qualifier	Net Result**	Corrected Result	Result	Uncertainty Uncertainty	0 0 0	Qualifier	Result	Uncertainty	MDC	Qualifier	Result	C-Uncertainty	38 WDC	Qualifier	Enrichment (%)	SOF LOS
L12-08-01-P-S-S-00	0.00	S	0.997	0.139	0.0502	N/A	-0.073	0.000	0.248	0.248	0.074	0.207	N/A	1.06	0.182	0.084	N/A	0.060	0.060	0.799	NA	NA	NA	0.0379	0.104	0.349	U	0.898	0.306	0.757	N/A	0.7	0.05
L12-08-02-P-R-S-00	0.50	S	1.13	0.149	0.0593	N/A	0.060	0.060	0.0459	0.046	0.029	0.219	U	1.2	0.164	0.116	N/A	0.200	0.200	1.393	NA	NA	NA	0.0691	0.136	0.54	U	1.29	0.524	0.786	N/A	0.9	0.15
L12-08-04-P-S-S-00	0.00	S	0.953	0.154	0.0741	N/A	-0.117	0.000	0.327	0.327	0.068	0.22	N/A	1.09	0.193	0.157	N/A	0.090	0.090	1.005	NA	NA	NA	0.0513	0.0479	0.597	U	0.75	0.346	0.944	U	1.1	0.07
L12-08-05-P-R-S-00	0.50	S	1.08	0.156	0.0634	N/A	0.010	0.010	0.0769	0.077	0.008	0.214	U	1.11	0.183	0.123	N/A	0.110	0.110	2.900	NA	NA	NA	0.16	0.153	0.199	U	0.671	0.323	0.866	U	3.6	0.09
L12-08-07-P-S-S-00	0.00	S	0.863	0.121	0.0563	N/A	-0.207	0.000	0.682	0.682	0.099	0.195	N/A	0.977	0.144	0.0866	N/A	-0.023	0.000	6.782	NA	NA	NA	0.373	0.12	0.171	N/A	1.82	0.52	0.735	N/A	3.1	0.08
L12-08-08-P-R-S-00	0.50	S	0.979	0.143	0.0653	N/A	-0.091	0.000	0.0718	0.072	0.095	0.218	U	1.07	0.166	0.118	N/A	0.070	0.070	1.100	NA	NA	NA	-0.037	0.0897	0.577	U	1.1	0.318	0.818	N/A	0.7	0.05
L12-08-10-P-S-S-00	0.00	S	0.913	0.136	0.0622	N/A	-0.157	0.000	0.205	0.205	0.069	0.215	U	1.01	0.153	0.108	N/A	0.010	0.010	3.945	NA	NA	NA	0.215	0.169	0.207	N/A	1.41		0.742	N/A	2.4	0.05
L12-08-11-P-R-S-00	0.50	S	0.926	0.142	0.0759	N/A	-0.144	0.000	0.0065	0.007	0.041	0.217	U	0.868	0.237	0.196	N/A	-0.132	0.000	1.110	NA	NA	NA	-0.148	0.19	0.68	U	1.11	0.349	0.914	N/A	0.7	0.01
L12-08-13-P-S-S-00	0.00	S	1.17 0.999	0.165 0.139	0.0739	N/A N/A	0.100	0.100	1.17 0.102	1.170 0.102	0.233	0.201	N/A U	1.2 1.03	0.168	0.0788	N/A N/A	0.200	0.200	4.677 0.969	NA NA	NA NA	NA NA	0.258	0.129	0.174	N/A	1.1 0.969	0.325	0.825	N/A N/A	0.7	0.23
L12-08-14-P-R-S-00 L12-08-16-P-S-S-00	0.50	S S	0.999	0.139	0.059	N/A	-0.088	0.000	0.102	0.102	0.095	0.213	N/A	1.15	0.148	0.0878	N/A	0.030	0.030	6.940	NA	NA	NA	0.382	0.0587	0.524	U N/A	1.83	0.201	0.791	N/A	3.2	0.03
L12-08-16-P-S-S-00	0.00	S	1.11	0.140	0.0777	N/A	0.040	0.040	0.128	0.430	0.122	0.212	U	1.04	0.202	0.138	N/A	0.040	0.040	8.552	NA	NA	NA	0.352	0.140	0.219	N/A	0.589	0.292	1.36	U	10.8	0.15
L12-08-19-P-S-S-00	0.00	S	0.667	0.099	0.0544	N/A	-0.403	0.000	0.219	0.219	0.028	0.203	N/A	0.965	0.165	0.091	N/A	-0.035	0.000	2.136		NA	NA	0.112	0.102	0.155	U	1.3	0.496	0.733	N/A	1.4	0.03
L12-08-20-P-R-S-00	0.50	S	0.968	0.16	0.0936	N/A	-0.102	0.000	-0.0064	0.000	0.045	0.214	U	0.879		0.142	N/A	-0.121	0.000	1.903	NA	NA	NA	0.101	0.213	0.357	U	0.996	0.541	0.839	N/A	1.6	0.02
L12-08-22-P-S-S-00	0.00	S	0.99	0.157	0.0758	N/A	-0.080	0.000	0.485	0.485	0.089	0.199	N/A	0.964	0.185	0.0751	N/A	-0.036	0.000	7.531	NA	NA	NA	0.416	0.157	0.229	N/A	1.51	0.395	0.964	N/A	4.2	0.02
L12-08-23-P-R-S-00	0.50	S	1.07	0.154	0.0731	N/A	0.000	0.000	0.0773	0.077	0.125	0.234	U	1.18	0.162	0.092	N/A	0.180	0.180	5.758	NA	NA	NA	0.318	0.119	0.169	N/A	1.04	0.537	0.834	N/A	4.6	0.13
L12-08-05-P-R-Q-00	0.50	Q	0.939	0.157	0.0901	N/A	-0.131	0.000	0.637	0.637	0.191	0.205	N/A	1	0.165	0.0946	N/A	0.000	0.000	6.750	NA	NA	NA	0.372	0.158	0.225	N/A	1.68	0.428	0.881	N/A	3.4	0.08
L12-08-17-P-R-Q-00	0.50	Q	1.14	0.155	0.0642	N/A	0.070	0.070	0.345	0.345	0.034	0.223	N/A	1.18	0.17	0.0936	N/A	0.180	0.180	3.049	NA	NA	NA	0.167	0.134	0.181	U	0.952	0.3	0.759	N/A	2.7	0.17
L12-08-25-P-S-B-00	0.00	в	0.890	0.132	0.067	N/A	-0.180	0.000	0.380	0.380	0.077	0.231	N/A	1.010	0.152	0.121	N/A	0.010	0.010	1.240	NA	NA	NA	-0.125	0.559	0.511	U	1.240	0.306	0.743	N/A	0.7	0.03
Systematic Mir	Systematic Minimum 0.000					0.000					0.00	00				0.7	99		-0.148					0.5	39		2.6	0.01					
Systematic Ma	Systematic Maximum 0.100						1.170					0.20	00				8.5	52			0.45	7			1.8	30		(%)	0.23				
Systematic N	lean				0.01	3					0.269					0.07	71				3.5	94			0.17	2			1.1	19		rage nent	0.08
Systematic M	edian				0.00	00					0.167					0.05	50				2.5	18			0.13	6			1.1	00		Ave	0.07
Systematic Standar	d Deviati	on			0.02						0.308					0.07	75				2.7	27			0.18	1			0.3	65		Enr	0.06
			With in	growth, u	se Ra226	bkg =		1.07		1. E.S.	11/2012	n an l		Th232	bkg =	1.0										C. S. C. S.				1.1.			

NOTES:

Gross results in units of pCi/g.

\* Background with ingrowth (1.07 pCi/g) subtracted from gross result.

\*\*Background (1.0 pCi/g) subtracted from gross result.

U Qualifier: Result is less than the sample detection limit.

All uncertainty values are reported at the 2-sigma confidence level.

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#### 42.2.5 Biased Soil Sample Result LSA 12-08

One (1) biased sample was collected from LSA 12-08. The sample collected at location L12-04-25 represented the maximum GWS measurement (13,902gcpm) within the SU, and had a result of 0.03 Uniform SOF.

### 42.2.6 Quality Control Soil Sample Result LSA 12-08

Two QC field duplicate sample points were randomly selected for LSA 12-08 which were collected at systematic locations L12-08-05 and L12-08-17.

For the 17 samples (i.e., 16 systematic + 1 biased) collected within LSA 12-08, two field duplicate samples were collected. This frequency equates to 11.8%, (i.e. 2/17). Form HDP-PR-FSS-703-1 documents that the duplicate sample result comparison with the partner's sample results that all comparison criteria were less than the calculated warning limits (see Figure 42-5 below).

Project	Revisi	Revision: 1													
	Form H	DP-PR-FS	S-703-1 H	ield <b>D</b>	Figure 42 Puplicate Sa		ssessment I	LSA 12-0	98 (1 of 2	2)					
Hematite	Procedure: HDP-PR	-FSS-703, Fin	al Status Sur	vey Qua	lity Control										
Decommissioning Project		Revision: 2 Page 1 of													
		<u> </u>	FIE		FORM HDP-I PLICATE SA		03-1 SSESSMENT			<u> </u>					
Survey Unit No.:	LSA 12-08	· · ·			Survey Unit D	Description:	Class 1 Laydow	n Land Are	a in "Area	13"	<u> </u>	· · · · · · · · · · · · · · · · · · ·			
Sample ID	Field Duplicate Sample ID	Radionuclide	Sample (p		Field Duplica (pCi/ Activity (x <sub>i</sub> )		Average Activity $(\bar{\chi})$ (pCi/g)	Nuclide DCGL (pCi/g)	Statistic <sup>2</sup>	Warning Limit	Control Limit	Statistic Exceeds Limit? (Y/N)			
L12-08-05-P-R-S-00	L12-08-05-P-R-Q-00	Ra-226	1.08	0.0634	0.939	0.0901	1.010	(peng) 1.9	0.141	0.269	0.403	N N			
L12-08-05-P-R-S-00	L12-08-05-P-R-Q-00	Tc-99	0.0769	0.214	0.637	0.205	0.357	25.1	NA	3.552	5.321	NA			
_12-08-05-P-R-S-00	L12-08-05-P-R-Q-00	Th-232	1.11	0.123	1	0.0946	. 1.055	2.0	0.110	0.283	0.424	N			
L12-08-05-P-R-S-00	L12-08-05-P-R-Q-00	U-234 <sup>1</sup>	2.900	N/A	6.750	N/A	4.825	195.4	3.849	27.649	41.425	N			
L12-08-05-P-R-S-00	L12-08-05-P-R-Q-00	U-235	0.16	0.199	0.372	0.225	0.266	51.6	NA	7.301	10.939	NA			
_12-08-05-P-R-S-00	L12-08-05-P-R-Q-00	U-238	0.671	0.866	1.68	0.881	1.176	168.8	NA	23.885	35.786	NA			
	to MDC available. Int is not necessary if the $\frac{1}{2}$			MDC.			Reviewed by: (	W. Cla	ihEvi	u/h	). Cl	L			
Date:	11-23-16	·					Date: ///	23/	16						

Decommissionin	g			ugh 12						•	Page 158 of		
Project	Revisio	on: 1										Page 138 0.	
	Form H	DP-PR-FS	S-703-1 F	ield D	Figure 42 uplicate Sa		ssessment I	LSA 12-0	)8 (2 of 2	2)			
Hematite	Procedure: HDP-PR	-FSS-703, Fin	al Status Su	vey Qua	ality Control								
Decommissioning Project								Revisi	ion: 2		Page 1	of 1	
	<u></u>	i	FII		FORM HDP- PLICATE SA		03-1 ASSESSMENT	<u></u>					
Survey Unit No.:	LSA 12-08				Survey Unit I	Description:	Class I Laydow	n Land Are	a in "Area	13"		r	
	Field Duplicate		Sample (J		Field Duplica (pCi/	-	Average Activity $(\bar{\chi})$	Nuclide DCGL		Warning		Statistic Exceeds Limit?	
Sample ID	Sample ID	Radionuclide	Activity (x <sub>i</sub> )		Activity (x <sub>i</sub> )	MDC	(pCi/g)	(pCi/g)	Statistic <sup>2</sup>	Limit	Limit	(Y/N)	
L12-08-17-P-R-S-00	L12-08-17-P-R-Q-00	Ra-226	1.11	0.0777	1.14	0.0642	1.125	1.9	0.03	0.269	0.403	N	
L12-08-17-P-R-S-00	L12-08-17-P-R-Q-00	Tc-99 Th-232	0.128	0.225	0.345	0.223	0.237	25.1 2.0	NA 0.140	3.552 0.283	5.321 0.424	NA N	
L12-08-17-P-R-S-00	L12-08-17-P-R-Q-00	-		1			1						
L12-08-17-P-R-S-00	L12-08-17-P-R-Q-00	U-234 <sup>1</sup> U-235	8.552 0.457	N/A 0.219	3.049 0.167	N/A 0.181	5.801 0.312	195.4 51.6	5.502 NA	27.649 7.301	41.425	N NA	
L12-08-17-P-R-S-00 L12-08-17-P-R-S-00	L12-08-17-P-R-Q-00 L12-08-17-P-R-Q-00	U-233	0.589	1.36	0.107	0.759	0.312	168.8	NA	23.885	35.786	NA	
	to MDC available. In the not necessary if the $\frac{1}{1 h c m c s} \frac{1}{2} 1$	,					Reviewed by:	w. 0	a.L.E.v	uz/U	S Ch	A	
Date:	11-23-16						Date: //	23/ 10	4				
Quality Record													

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#### 42.3 Tc-99 Hot Spot Assessment LSA 12-08

There is no historical sampling data available for this area since it was always considered a nonimpacted area prior to the storage of potential reuse soils within the LSA. As a previously unimpacted area there is no history of a Tc-99 sample result ever exceeding the Tc-99 Uniform DCGL<sub>w</sub>, as only potential reuse soil was placed within the LSA. The highest Tc-99 sample result collected from both Final RASS and FSS was 2.42 pCi/g. Therefore there is no concern for a potential Tc-99 hot spot exceeding the DCGL<sub>w</sub> of 25.1, and there is no reason to perform a Tc-99 hot spot assessment.

#### 43.0 ALARA EVALUATION LSA 12-08

All samples collected within LSA 12-08 were evaluated against the Uniform Stratum DCGL<sub>w</sub>. For LSA 12-08 no sample result exceeded a SOF of 1.0. The average SOF result, based on all systematically collected samples, was 0.08 for LSA 12-08. The average SOF equates to residual activity contributions from the survey unit area of 2.0 mrem/yr for LSA 12-08. Groundwater Monitoring Well data provided in FSSFR Volume 6, Chapters 2 and 3 {ML16287A528} and Chapter 4 {ML16342B552}, indicate that the groundwater dose contribution will be a fraction of the MCLs. Nevertheless, a maximum groundwater contribution assumption of 4.0 mrem/yr based upon the EPA MCLs will be added to the total estimated dose for LSA 12-08. Adding these dose contributions together, the total estimated dose for LSA 12-08 is 6 mrem/yr.

Since the estimated Total Effective Dose Equivalent is well below the regulatory release criterion of 25 mrem/yr, the conclusion of the ALARA evaluation is that the FSS of LSA 12-08 was successful and that there would be no discernable benefit to the health and safety of the public in attempting to further reduce the results of FSS by performing remediation of LSA 12-08.

#### 44.0 FSS PLAN DEVIATIONS LSA 12-08

#### 44.1 Remedial Actions during FSS

There was no remedial action in LSA 12-08.

#### 44.2 Adjustments to Scan MDC Calculations

Scan MDCs for LSA 12-08 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD- FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. The assumed LSA background count rate of 10,000 cpm was applied to determine the prospective Scan MDCs, and the actual mean count rate from the FSS survey was 9,769 cpm. Therefore the calculated Scan MDCs are appropriate, and no adjustments need to be made.

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# 45.0 DATA QUALITY ASSESSMENT

The DQO process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process are presented in Volume 3, Chapter 1, Section 4.0 of the FSSFR and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

### 45.1 Data Quality Assessment for LSA 12-08

The Data Quality Assessment of the survey methodology, sampling and sample analysis results, and the Quality Control sampling and analysis results to ascertain the validity of the conclusion for LSA 12-08 (see Figure 45-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-416 (*Operation of the Ludlum 2221 for Final Status Survey*).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.
- The systematic samples that were collected (on a random-start triangular grid) and the gamma scan surveys that were conducted were performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.
- All samples sent for analysis at the approved offsite laboratory (TestAmerica) were tracked on a chain of custody form in accordance with HDP-PR-QA-006, *Chain of Custody*.
- Quality Control sample results were verified to meet the acceptance criteria as specified in HDP-PR-FSS-703, *Final Status Survey Quality Control*.
- LSA 12-08 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.
- The WRS Test is not necessary when the difference between the maximum survey unit data set measurement SOF and the minimum background area measurement SOF is less than or equal to one. For LSA 12-08, no individual gross SOF result in the FSS data set exceeded the SOF of the minimum background reference area measurement by more than one using the Uniform Stratum criteria. Therefore, the WRS Test was not required for LSA 12-08. However the WRS Test was still performed for illustrative purposes. Since the test statistic, WR (1040) exceeded the critical value (860), the FSS data set passed the WRS Test and the null hypothesis was rejected. The WRS Test worksheet is presented in Appendix F.
- A biased soil sample was collected from the location of the highest gamma count rate within the SU, and the result was a 0.03 Uniform SOF.

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•	The maximum SOF result for all surface samples where $r_{n}$ The maximum SOF result for all subsurface samples. The average SOF result for all systematically collected was 0.08, with an upper 95% confidence level (UCL <sub>n</sub> )	within LSA 12-08 was 0.15. ed samples within LSA 12-08
•	No FSS sample result in LSA 12-08 exceeded a SC Uniform Stratum criteria, therefore an EMC or supp not required. For the same reason, no comparisons to multi-CSM (i.e. Surface, Root and Excavation) DCG	plemental investigations was o the alternate "Three-Layer"
•	A retrospective sampling frequency evaluation was sufficient statistical power exists to reject the null h number (8) of systematic samples actually collected successful result of the retrospective power evaluatio LSA 12-08 indicates that the minimum number of WRS Test were equal to the number of sampling within LSA 12-08. The methodology used for frequency evaluation is similar to the prospective performed during FSS Plan Development except th and statistics are used in the sample size verification standard deviation of the eight LSA surface samples data set) are used to derive the relative shift for each and Type II errors of 0.05 and 0.10, respectively, th then correlated to a minimum sample size number MARSSIM.	hypothesis based on the total ed within LSA 12-08. The in presented in Table 10-1 for samples required (8) for the locations actually collected the retrospective sampling e sample size determination at actual FSS sample results a. Specifically, the mean and s (i.e., the WRS Test sample LSA. Given the HDP Type I he calculated relative shift is
•	HDP staff ensured that a visual inspection of the s Isolation & Control measures were performed period there were no instances of potential cross contaminat the FSS of all remaining areas at HDP were complete	odically, and confirmed that ion from weather events until

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# Table 45-1 **Retrospective Sample Size Verification for LSA 12-08**

N/2 Value Verification				
lsotope(s)	SOF (Ra/Tc/Th/Iso U)			
St. Dev.	0.06			
DCGL <sub>SOF</sub>	1			
LBGR (Mean)	0.08			
Shift	0.92			
Relative Shift (Δ/σ)	15.33			
MARSSIM Table 5.1 (Pr)	1.000000			
Ν	12			
N + 20%	14.4			
N/2	8			
FSS N/2	8			
Verification Check	SUFFICIENT MEASUREMENT			

"N/2" Corresponds to the number of survey unit measurement locations required for the WRS Test

MARS	SIM Table 5.1
Δ/σ	Pr
0.1	0.528182
0.2	0.556223
0.3	0.583985
0.4	0.611335
0.5	0.638143
0.6	0.664290
0.7	0.689665
0.8	0.714167
0.9	0.737710
1.0	0.760217
1.1	0.781627
1.2	0.801892
1.3	0.820978
1.4	0.838864
1.5	0.855541
1.6	0.871014
1.7	0.885299
1.8	0.898420
1.9	0.910413
2.0	0.921319
2.25	0.944167
2.5	0.961428
2.75	0.974067
3.0	0.983039
3.5	0.993329
4.0	0.997658
4.01	1.000000

# MARSSIM Table 5.2, $\alpha = 0.05$ , $\beta = 0.10$

α (or β)	Z <sub>1-α</sub> (or Z <sub>1-β</sub> )
0.005	2.576
0.01	2.326
0.015	2.241
0.025	1.960
0.05	1.645
0.10	1.282
0.15	1.036
0.2	0.842
0.25	0.674
0.30	0.524



Homotito	FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12, Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)		
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Hematit		Procedure: HDP-PR-F	SS-721, Final Statu	is Survey Data Eva	luation		
Decommissi Project	oning	•		Revision:		ppendix G-1. age 1 of 2	
F	INAL S	STATUS SURVEY DA	APPENDIX ( ATA QUALITY O		VIEW CHE	CKLI	ST
Survey A	Area:	LSA 12	Description:	Laydown Area, P	Plant Soils SE	ĒA	
Survey (	Unit:	08	Description:	Class 1 Laydown	Land Area i	n "Are	a 13"
to d	ata ana	easurements and/or and lysis for FSS been ind with Section 8.1 of this	vidually reviewed		Yes 🔀	No 🗌	]
acqu		ystematic measurement the locations specified s?			Yes 🔀	No 🗌	]
		cans surveys been pe the FSSP and the FSS			Yes 🔀	No 🗌	]
		ased measurements and ions specified in the FS			Yes 🔀	No 🗌	] NA 🗌
		cate and/or split samp each location designate			Yes 🔀	No 🗌	] NA 🗌
capa	able of	nstruments used to m detecting the ROCs or iate investigation level	gross activity at a		Yes 🔀	No 🗌	]
anal	lyze dat	llibration of all instrun ta, current at the time using a NIST traceable	of use and were the		Yes 🔀	No 🗌	]
		nstruments successfully ired, after use on the da			Yes 🖂	No 🗌	] .
9. Do 1	the sam	ples match those identi	fied on the chain of	custody?	Yes 🔀	No	] NA 🗌
		Sample Results meet th SS-703, Final Status Su			Yes 🔀	No	]
11. Are	all Lab	oratory QC parameters	within acceptable	limits?	Yes 🖂	No 🗌	]
		e response to any of the response to any of the taken to res			he discrepan	icy as	well as any
Commen	its: N/A	A					

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Hematite	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation						
ecommissioning Project					Revision: 1	0 Appendix G-1 Page 2 of 2	,
FINAL	STATUS SURV		APPENDIX G QUALITY OI		REVIEW CHEC	CKLIST	_
Survey Area:	LSA 12				a, Plant Soils SE		
Survey Unit:	08		Description:	Class I Layde	own Land Area i	n "Area 13"	
Discrepancy:	N/A	•					
			_				
, . , . ·					<u> </u>		
				=	<u> </u>		
Corrective Act	ions Taken: <u>N/</u>	<u>A</u>				-	- - - - - - - - -
Corrective Act						· · · · · · · · · · · · · · · · · · ·	
11. Have the	corrective actions	s resolved th	e discrepancy v	· · · · · · · · · · · · · · · · · · ·		· · · · · · · · · · · · · · · · · · ·	
11. Have the a. If "No	corrective actions	s resolved th	e discrepancy v e RSO.	with the data?			
<ul> <li>11. Have the a. If "No</li> <li>12. The follo</li> </ul>	corrective actions ", then forward th wing questions w	s resolved th this form to the ill be answe	e discrepancy v le RSO. red by the RSO	with the data?	Yes	No 🗌 NA 🔀	
<ul> <li>11. Have the a. If "No</li> <li>12. The follo</li> </ul>	corrective actions ", then forward th wing questions w unswer to question	s resolved th this form to the ill be answe	e discrepancy v le RSO. red by the RSO	with the data?	Yes		
<ul> <li>11. Have the</li> <li>a. If "No</li> <li>12. The follo</li> <li>a. If the a still va</li> <li>b. If "No</li> </ul>	corrective actions ", then forward th wing questions w unswer to question lid? ", then are the exi	s resolved th tis form to th ill be answe n 11 was "N isting valid r	e discrepancy w the RSO. red by the RSO o", then is the a measurements of	with the data?	Yes Yes	No 🗌 NA 🔀	
<ul> <li>11. Have the</li> <li>a. If "No</li> <li>12. The follo</li> <li>a. If the a still va</li> <li>b. If "No suffici</li> <li>c. If "No</li> </ul>	corrective actions ", then forward th wing questions w unswer to question lid?	s resolved th tis form to th til be answe n 11 was "N isting valid r e complianc acquisition o	e discrepancy we are a solution of the solution of additional models and the solution of addition of the solution of the solut	with the data?	Yes Yes Yes Yes	No 🗌 NA 🕅 No 🗌 NA 🕅 No 🗌 NA 🕅	
<ul> <li>11. Have the</li> <li>a. If "No</li> <li>12. The follo</li> <li>a. If the a still va</li> <li>b. If "No suffici</li> <li>c. If "No demor</li> </ul>	corrective actions ", then forward th wing questions w unswer to question did? ", then are the exi ent to demonstrate ", then direct the	s resolved th tis form to th til be answe n 11 was "N isting valid r e complianc acquisition o	e discrepancy we are a solution of the solution of additional models and the solution of addition of the solution of the solut	with the data?	Yes Yes Yes Yes samples as nece	No 🗌 NA 🕅 No 🗌 NA 🕅 No 🗌 NA 🕅	

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# 46.0 CONCLUSION LSA 12-08

An adequate quantity and quality of radiological surveys and samples, as well as the corresponding laboratory analysis has been performed, evaluated and documented to demonstrate that the dose associated with all sources within SU LSA 12-08 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402.

	· · · · · · · · · · · · · · · · · · ·	LOA 12-00 DOI and	Dose Summ	auon		
	AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	BURIED PIPING	REUSE SOIL	TOTAL
SOF	. 0.08	N/A	0.16	N/A	N/A	0.24
DOSE	2.0 mrem/year	N/A	4.0 mrem/year	N/A	N/A	6.0 mrem/year

Table 46-1LSA 12-08 SOF and Dose Summation

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# 47.0 FINAL STATUS SURVEY DESIGN LSA 12-09

This section of the report describes the method for determining the number of samples required for the FSS of LSA 12-09 as well as summarizing the applicable requirements of the FSS Plan. These include the  $DCGL_W$ , scan survey coverage, and IAL. The radiological instrumentation used in the FSS of LSA 12-09 and the detection sensitivities are also discussed.

# 47.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 12-09 were driven by the type (Open Land) and Class (Class 1) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development*, November 2015.

# **47.1.1 Surrogate Evaluation Areas**

A discussion of Surrogate Evaluation Areas is given in the FSSFR Volume 3, Chapter 1, Section 5.0, *Final Status Survey Design*.

# 47.1.2 DCGL<sub>w</sub>

During the FSS design process a review was performed of the RASS data for LSA 12-09. The RASS data was used as confirmation that no known areas of residual radioactivity remained within the survey areas that exceeded the Uniform Stratum  $DCGL_w$ . Therefore the Uniform Stratum  $DCGL_w$  was selected for use in demonstrating compliance with the release criteria.

# 47.1.3 GWS Coverage

As a Class 1 SU, LSA 12-09 was required to undergo a 100% GWS.

# 47.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 12-09 was the Ludlum 44-10 2" x 2" NaI detectors, coupled to a Ludlum 2221 scaler-ratemeter.

# 47.1.5 Scan Minimum Detectable Concentration

Scan MDCs for LSA 12-09 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD- FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. As background levels were approximately 10,000 cpm within LSA 12-09, the scan MDC calculation for total uranium given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.2.6.d, was applied:

Scan MDC (total uranium) = 
$$\frac{1}{\left(\left(\frac{f_{U-234}}{3659 \ pCi/g}\right) + \left(\frac{f_{U-235}}{2.32 \ pCi/g}\right) + \left(\frac{f_{U-238}}{30.6 \ pCi/g}\right)\right)}$$

Equation 47-1

To determine isotopic Uranium fractions HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* assumes that the average LSA enrichment is 4% or less. Based on the

Hematite	FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12,		
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systematically collected RASS samples in LSA 12-09, the average enrichment for the SU was 2.96%. All other Scan MDC parameters agreed upon between Westinghouse and the NRC were applied (e.g. use of a 2 in air gap, scan rate of 1 ft/sec, 0.75 surveyor efficiency), therefore no subsequent changes to the calculated Scan MDCs need to be made.

Prospectively calculated Scan MDCs for 2" x 2" NaI detectors that were used in LSA 12-09 are shown below:

Table 47-1Scan MDCs for 2" x 2" NaI detector, 10,000 cpm background: LSA 12-09

· .	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 12-09	40.9	46.6	0.87	2.8	1.21	3.0

\*DCGL<sub>w</sub> includes background concentrations of 0.9 pCi/g for Ra-226 (no ingrowth) and 1.0 pCi/g for Th-232. DCGLw values are based on the Uniform Stratum release criteria.

The values in Table 47-1 reflect those presented in the FSS Plans prepared for the SU prior to FSS.

## 47.1.6 Investigation Action Level

FSSFR Volume 3, Chapter 1, Section 6.1.3, *Investigation Action Level (IAL)*, provides a discussion in regards to the IAL. The basis of the IAL is detailed in HDP memorandum, HEM-15-MEMO-021 "Evaluation of the Scan IAL for Class 1 areas at the Westinghouse Hematite Site". The IAL used during the GWS of LSA 12-09 was established at 4,000 ncpm.

## 47.1.7 LSA 12-09 FSS Design Summary

The FSS Plans for LSA 12-09 can be found in Appendix N. Table 47-2 presents an overall FSS design and implementation summary for LSA 12-09.

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	<u> </u>		
	FSS	Table 47-2Design Summary for	ST I SA 12 00
			1 LSA 12-07
Gamma Walko Scan Coverage	ver Survey (GWS):		100% exposed soil and rock
Scall Coverage			40.9 pCi/g total Uranium (based on a 10,000
Scan MDC			cpm background); $0.87 \text{ pCi/g Th-}232; 1.21$
			oCi/g Ra-226*
Investigation Ac	ction Level (IAL)		4,000 net cpm **
Systematic San	npling Locations:		
	Depth	Number of Sample	Comments
	m (Surface)	8	These samples will be taken on a
	1.5 m (Root)	. 8	random-start systematic grid.
	Excavation) Sampling Locations	8	
analysis of the s Sidewall Samp	urvey data, or at the ling Locations:	direction of the RSO or	cretion of the HP Technician, after statistical Radiological Engineering.
analysis of the s Sidewall Samp A minimum of	urvey data, or at the ling Locations: one (1) discretionary	direction of the RSO or v sidewall sample will	
analysis of the s Sidewall Samp A minimum of of "sidewall": si 12" in height. Instrumentatio Ludlum 2221 v collimation for i	urvey data, or at the ling Locations: one (1) discretionary idewall candidates for n: vith 44-10 (2x2 NaI investigations	direction of the RSO or sidewall sample will or sampling must be ver ) detector; with Used biase	Radiological Engineering. be collected based on the following definition rtical or near vertical (> 45° angle) and at least d for GWS and to obtain static count rates at ed measurement locations.
analysis of the s Sidewall Sampl A minimum of of "sidewall": si 12" in height. Instrumentatio Ludlum 2221 v collimation for *Values based of Scanning Minim for total Uraniu (2.0%) would re *IAL is the ne	urvey data, or at the ling Locations: one (1) discretionary idewall candidates for in: with 44-10 (2x2 Nal investigations on information prov num Detectable Con im reflects a conserve esult in Scan MDC va of count per minute (	direction of the RSO or v sidewall sample will or sampling must be ver ) detector; with Used biase ided in HDP-TBD-FSS centrations (MDC) for vative assumption of 4 alues slightly less than to (ncpm) equivalent of an technical bases present	Radiological Engineering. be collected based on the following definition rtical or near vertical (> 45° angle) and at least

	FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12, Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)				
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## 48.1 Gamma Walkover Survey

## 48.1.1 Instrumentation

The selected instrumentation to perform the GWS in LSA 12-09 was a 2" x 2" NaI detector in combination with a Ludlum 2221 rate meter. Each NaI instrumentation set was interfaced with a Trimble DGPS and handheld data logger.

Prior to the first field use of the GWS instrumentation, initial set-ups were performed. Also, daily pre- and post-use source checks were performed for each day that GWS was performed within the SU. Initial set-ups, daily source checks, and control charting were performed according to the requirements of HDP-PR-HP-416, *Operation of the Ludlum 2221 for Final Status Survey*.

# 48.1.2 GWS Performance

All GWS measurements on the excavation floor and sidewalls collected with the NaI detector(s) were connected to a Trimble DGPS and with a hand-held data logger. The logging frequency in the survey unit was 1 GWS measurement per second. Each gross gamma measurement is correlated to a set of coordinates based on the Missouri East State Plane, NAD 1983.

The GWS requirements involved moving the NaI detector in a side-to-side fashion no faster than 1 foot per second while holding the probe as close as possible to the excavation surface (nominally 1", but not to exceed 3"). At the same time, the technician was required to slowly advance, causing the detector to trace out a serpentine path over the excavation surface.

FSS Technicians performing GWS in LSA 12-09 used the 4,000 ncpm IAL as a field guide to know when to slow or pause the GWS for more deliberate investigation. If during the GWS, audible count rates noticeably increase above the general area average (i.e., > minimum detectable count rate), FSS Technicians were required to pause momentarily and observe count rates. If sustained count rates approached the IAL, further focused investigation was conducted within the locally elevated area.

To use the IAL effectively, FSS Technicians first determined the local background count rate before starting the GWS. Although the ambient gamma level may vary across the SU due to excavation geometry and relative distance from contaminated materials in nearby remedial excavations, the average background rate (measured at waist level) within the LSA ranged between 10,000 and 11,000 gcpm. Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 14,000 to 15,000 gcpm, FSS Technicians slowed or paused the GWS for more careful investigation of the small areas of elevated activity before deciding if "flagging" a point for potential biased sampling was warranted.

Hard to reach areas, and non-typical areas were surveyed manually as necessary in order to assess the potential for an area of elevated residual activity over 100% of the exposed ground surface.

After the GWS survey was complete, the GPS/GWS data was reviewed by Radiological Engineering and the Health Physics Technician performing the survey to determine if possible areas of elevated residual activity remained within the SU that required biased sample

Hematite	FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12,			
Decommissioning	Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)			
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investigation. Areas that were flagged by the HP Technician were considered, as well as a statistical evaluation of the GWS data set. The statistical evaluation determined the mean count rate and standard deviation associated with the GWS and then could be used to identify any areas that exceeded 3 standard deviations above the mean. The number of biased samples to be collected and the locations are based on flagged locations exceeding the IAL, the statistical evaluation of the GWS data set, and the professional judgment of Radiological Engineering.

# 48.2 Soil Sampling

# 48.2.1 Systematic Soil Sampling Summary

Table 48-1 provides a summary of systematic sampling by stratum for LSA 12-09.

Systematic Sampling Summary by Stratum for LSA 12-09						
	SU Area,		Systematic			
LSA	planar (m <sup>2</sup> )	Surface	Root	Deep	QC	
		Surface		(Excavation)		
12-09	1,747	8	8	8*	2	

# Table 48-1Systematic Sampling Summary by Stratum for LSA 12-09

\*Excavation samples were collected and archived, analysis only required if a overlying Root sample exceeds a 0.5 SOF

# 48.2.2 Systematic Sampling LSA 12-09

Within LSA 12-09, there were 8 systematic locations in which the surface stratum [0 - 15] centimeters (cm)] was sampled in the SU. The underlying root stratum was sampled at all 8 locations. Excavation stratum samples were collected and archived, but were not required to be analyzed since no root stratum sample exceeded a 0.5 Uniform SOF.

Given a planar area of 1,747  $\text{m}^2$  for LSA 12-09 and an eight - point systematic triangular grid, the point-to-point distance within each row was 15.8 m with spacing of 13.7 m between each of the parallel grid rows within the SU.

While there were eight (8) systematic locations on the LSA 12-09 sampling grid, a total of eighteen (18) samples were collected and analyzed at these locations, including:

- Eight (8) samples collected and analyzed within the surface stratum
- Eight (8) samples collected and analyzed within the root stratum
- Zero (0) samples analyzed within the excavation, or "deep" stratum
- Two (2) QC field replicate

Figure 48-1 presents the map of the eight systematic sample locations which were sampled within LSA 12-09. The inset table notes the location coordinates (Missouri East, NAD 1983) and collection intervals for each systematic location.

	Hematite Decommissioning	FSSFR Volume 3, Chapter 9: Survey Area 08, and 09 (LSA 12-03 through 12-09)	Release Record for Land Survey Area 12, Survey Units 03, 04, 05, 06, 0
	e	Revision: 1	Page 171 of 191
$ \frac{1}{120900P+5500} \underbrace{120900P+5500}{120900P+5500} \underbrace{120900P+5500}{120900P+5500} \underbrace{120900P+5500}{120900P+5500} \underbrace{120900P+5500}{120900P+5500} \underbrace{120900P+5500}{120900P+5500} \underbrace{120900P+5500}{120900P+5500} \underbrace{120900P+5500}{120900P+5500} \underbrace{120900P+5500}{120900P+5500} \underbrace{120900P+5500}{12090P+5500} \underbrace{120900P+5500}{12090P+5500} \underbrace{120900P+5500}{12090P+5500} \underbrace{12090P+5500}{12090P+5500} \underbrace{12090P+5500}{1209P+2500} \underbrace{12090P+5500}{1209P+2500} \underbrace{12090P+5500}{1209P+2500} \underbrace{12090P+5500}{1209P+2500} \underbrace{1200P+2500}{1209P+2500} \underbrace{120P+2500}{1200P+2500} \underbrace{120P+2500}{1200P+2500} \underbrace{120P+2500}{120P+2500} \underbrace{120P+2500}{120P$			
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Hematite E	L12-09-01-P-S-S- L12-09-02-P-R-S- L12-09-03-P-E-S- L12-09-03-P-E-S-	00 00 00 12-09-04-P-S-S-00 12-09-05-P-R-S-00 00 00 00 00 00 00 00 00 00
Import         (inches)         <	/	L12-09-	07-P-S-S-00 L12-09-11-P-R-S-00
L12-09-14-PS-500 0 6 856742 828039 L12-09-04-PS-500 0 6 59 865742 828039 L12-09-04-PS-500 0 6 856742 828039 L12-09-05-PS-500 0 6 856742 828031 L12-09-05-PS-500 0 6 865678 828065 L12-09-05-PS-500 0 6 865697 828065 L12-09-14-P-R-Q-00 L12-09-14-P-R-S-00 L12-09-14-P-R-Q-00 L12-09-17-P-R-S-00 L12-09-14-P-R-Q-00 L12-09-17-P-R-S-00 L12-09-14-P-R-Q-00 L12-09-17-P-R-S-00 L12-09-14-P-R-S-00 L12-09-14-P-R-S-00 L12-09-14-P-R-Q-00 L12-09-14-P-R-S-00 L12-09-14-P-R-S-00 L12-09-14-P-R-S-00 L12-09-14-P-R-S-00 L12-09-14-P-R-S-00 L12-09-14-P-R-S-00 L12-09-20-P-R-S-00 L12-09-20-P-R-S-00 L12-09-22-P-S-S-00 L12-09-20-P-R-S-00 L12-09-22-P-S-S-00 L12-09-20-P-R-S-00 L12-09-22-P-S-S-00 L12-09-20-P-R-S-00 L12-09-22-P-S-S-00 L12-09-20-P-R-S-00 L12-09-22-P-S-S-00 L12-09-22-P-S-S-00 L12-09-22-P-S-S-00 L12-09-22-P-S-S-00 L12-09-22-P-S-S-00 L12-09-22-P-R-S-00 L12-09-22-P-R-S-00 L12-09-22-P-R-S-00 L12-09-22-P-R-S-00 L12-09-22-P-R-S-00 L12-09-22-P-R-S-00 L12-09-22-P-R-S-00 L12-09-22-P-S-S-00 L12-09-22-P-R-S-00 L12-09-22-P-S-S-00 L12-09-22-P-R-S-00 L12-09-22-P-S-S-00 L12-09-22-P-R-S-00 L12-09-22-P-S-S-00 L12-09-22-P-R-S-00 L12-09-22-P-R-S-00 L12-09-22-P-R-S-00 L12-09-22-P-R-S-00 L12-09-22-P-R-S-00 L12-09-22-P-R-S-00 L12-09-22-P-R-S-00 L12-09-22-P-R-S-00 L12-09-22-P-R-S-00 L12-09-22-P-R-S-00 L12-09-22-P-R-S-00 L12-09-22-P-R-	Sample ID		
11209-02-P.R-S-00       6       59       865742       828039         112-09-03-P-R-S-00       6       856742       828091         112-09-05-P-R-S-00       6       59       865742       828091         112-09-05-P-R-S-00       6       59       865742       828091         112-09-05-P-R-S-00       6       59       865742       828091         112-09-05-P-R-S-00       6       59       865697       828065         112-09-05-P-R-S-00       6       59       865697       828065         112-09-05-P-R-S-00       6       59       865697       828065         112-09-11-P-R-S-00       6       59       865697       828117         112-09-11-P-R-S-00       6       59       865697       828117         112-09-14-P-R-S-00       6       59       865652       828091         112-09-14-P-R-S-00       6       59       865562       828117         112-09-14-P-R-S-00       6       59       865562       828131         112-09-14-P-R-S-00       112-09-14-P-R-S-00       112-09-22-P-S-S-00       112-09-22-P-S-S-00         112-09-14-P-R-S-00       6       59       865562       828143       12-09-22-P-R-S-00       12-09-22-P-R-S-00	112-09-01-P-S-S-0		LSA 12-09
112-09-03-PE-S-00       59       65       865742       828091         112-09-04-PS-S-00       0       6       865742       828091         112-09-05-PR-S-00       6       59       865742       828091         112-09-05-PR-S-00       6       59       865742       828091         112-09-07-PR-S-00       0       6       865697       828065         112-09-07-PR-S-00       59       65       865697       828065         112-09-17-PR-S-00       59       65       865697       828117         112-09-17-PR-S-00       6       59       865697       828117         112-09-14-PR-S-00       6       59       865697       828117         112-09-14-PR-S-00       6       59       865697       828117         112-09-14-PR-S-00       6       59       865697       828143         112-09-14-PR-S-00       6       59       865697       828143         112-09-14-PR-S-00       6       59       865697       828143         112-09-14-PR-S-00       112-09-24-PR-S-00       112-09-23-P.R-S-00       112-09-24-P.E-S-00         112-09-14-PR-S-00       6       59       865607       828117         112-09-21-PR-S-00			1747 m <sup>2</sup> Planar Area
112-09-05-P-R-S-00       6       59       865742       828091         112-09-05-P-R-S-00       59       65       865742       828091         112-09-07-P-S-500       0       6       855697       828065         112-09-10-P-S-500       6       59       865697       828065         112-09-10-P-S-500       0       6       865697       82817         112-09-11-P-R-S-00       6       59       865697       828117         112-09-12-P-E-S-00       0       6       865697       828117         112-09-13-P-S-S-00       0       6       865697       828117         112-09-13-P-S-S-00       0       6       865697       828117         112-09-13-P-S-S-00       0       6       865652       828091         112-09-13-P-S-S-00       112-09-20-P-R-S-00       112-09-23-P-R-S-00       112-09-23-P-R-S-00         112-09-13-P-S-S-00       0       6       865652       828131         112-09-13-P-R-S-00       6       59       865652       828143         112-09-13-P-R-S-00       112-09-23-P-R-S-00       112-09-23-P-R-S-00       112-09-23-P-R-S-00         112-09-13-P-R-S-00       6       59       865607       828117 <td< td=""><td></td><td></td><td></td></td<>			
L1209-06-PE-5-00 L1209-06-PE-5-00 L1209-07-P5-5-00 L1209-09-PE-5-00 L1209-09-PE-5-00 L1209-09-PE-5-00 L1209-09-PE-5-00 L1209-09-PE-5-00 L1209-09-PE-5-00 L1209-09-PE-5-00 L1209-09-PE-5-00 L1209-09-PE-5-00 L1209-09-PE-5-00 L1209-09-PE-5-00 L1209-09-PE-5-00 L1209-09-PE-5-00 L1209-09-PE-5-00 L1209-09-PE-5-00 L1209-09-14-P-R-S-00 L1209-19-P-S-S-00 L1209-19-P-S-S-00 L1209-19-P-S-S-00 L1209-19-P-S-S-00 L1209-19-P-S-S-00 L1209-19-P-S-S-00 L1209-19-P-S-S-00 L1209-19-P-S-S-00 L1209-19-P-S-S-00 L1209-19-P-S-S-00 L1209-19-P-S-S-00 L1209-19-P-S-S-00 L1209-19-P-S-S-00 L1209-19-P-S-S-00 L1209-19-P-S-S-00 L1209-20-P-R-S-00 L120-92-P-R-S-00 L120-92-P-R-S-00 L120-92-P-R-S-00 L120-92-P-R-S-00 L120-92-P-R-S-00 L120-92-P-R-S-00 L120-92-P-R-S-00 L120-92-P-R-S-00 L120-92-P-R-S-00 L120-92-P-R-S-00 L120-92-P-R-S-00 L120-92-P-R-S-00 L120-92-P-R-S-00 L120-92-P-R-S-00 L120-92-P-R-S-00 L120-92-P-R-S-00 L120-92		0 6 865742 828091	
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L12-09-07-F3-300 0 0 0 0 00509 028065 L12-09-09-F8-500 59 65 865697 82805 L12-09-19-P8-500 0 6 865697 828117 L12-09-19-P8-5-00 L12-09-18-P-E-S-00 L12-09-19-P-S-5-00 L12-09-18-P-E-S-00 L12-09-19-P-S-5-00 L12-09-22-P-S-S-00 L12-09-19-P-S-S-00 L12-09-23-P-R-S-00 L12-09-20-P-R-S-00 L12-09-23-P-R-S-00 L12-09-24-P-E-S-00 L12-09-24-P-E-S-00 L12-09-24-P-E-S-00 L12-0			L12.09.15 P E S 00
112:09:09:PF:K:300       0       0       38:00:09       81:20:09         112:09:09:PF:K:300       0       6       86:5697       82:80:05         112:09:11:P:R:500       6       59       86:5697       82:81:17         112:09:12:PF:K:00       59       65       86:5652       82:8091         112:09:14:P:R:500       6       59       86:5652       82:8091         112:09:14:P:R:500       6       59       86:5652       82:8091         112:09:14:P:R:500       6       59       86:5652       82:8091         112:09:14:P:R:5:00       59       65       86:5652       82:8091         112:09:14:P:R:5:00       59       65       86:5652       82:8143         112:09:14:P:R:5:00       59       65       86:5652       82:8143         112:09:14:P:R:5:00       59       65       86:5652       82:8143         112:09:14:P:R:5:00       59       65       86:5607       82:8117         112:09:22:P:S:5:00       0       6       86:5607       82:8117         112:09:22:P:S:5:00       0       6       86:5607       82:8169         112:09:22:P:S:5:00       0       6       86:5607       82:8169         112:0			
L12.09       10.P.5.5.00       0       6       865697       828117         L12.09       11.P.R.5.00       6       59       865697       828117         L12.09       12.09       12.P.E.S.00       59       65       865697       828117         L12.09       12.09       14.P.R.5.00       6       59       865652       828091         L12.09       12.09       14.P.R.5.00       6       59       865652       828091         L12.09       12.09       14.P.R.5.00       6       59       865652       828143         L12.09       12.09 <t< td=""><td></td><td></td><td></td></t<>			
112.09-11-P.R.5.00       6       59       865697       828117         112.09-12-P.E.5.00       59       65       865697       828117         112.09-13-P.5.5.00       0       6       865652       828091         112.09-15-P.E.5.00       59       65       865652       828091         112.09-15-P.E.5.00       59       65       865652       828091         112.09-15-P.E.5.00       6       59       865652       828143         112.09-16-P.S.5.00       6       59       865652       828143         112.09-17-P.R.5.00       6       59       865652       828143         112.09-18-P.S.5.00       0       6       865652       828143         112.09-19-P.S.5.00       0       6       865652       828143         112.09-19-P.S.5.00       0       6       865652       828143         112.09-21-P.E.5.00       59       65       865607       828117         112.09-21-P.E.5.00       59       65       865607       828117         112.09-22-P.S.5.00       0       6       59       865607       828169         112.09-23-P.R.5.00       6       59       865607       828169         112.09-24-P.E.5.0			
L12-09-12-P.E.S-00       59       65       865697       828117         L12-09-13-P.S-S-00       0       6       865652       828091         L12-09-14-P.R-S-00       6       59       865652       828091         L12-09-15-P.E-S-00       59       65       865652       828091         L12-09-16-P.S-S-00       0       6       865652       828143         L12-09-16-P.S-S-00       0       6       865652       828143         L12-09-17-P.R-S-00       6       59       865652       828143         L12-09-19-P.S-S-00       L12-09-22-P.S-S-00       L12-09-23-P.R-S-00         L12-09-19-P.S-S-00       0       12-09-24-P.E-S-00       L12-09-24-P.E-S-00         L12-09-19-P.S-S-00       0       6       865607       828117         L12-09-21-P.E-S-00       59       65       865607       828117         L12-09-22-P.S-S-00       0       6       865607       828117         L12-09-22-P.S-S-00       0       6       865607       828117         L12-09-22-P.S-S-00       0       6       865607       828169         L12-09-22-P.S-S-00       0       6       865607       828169         L12-09-22-P.S-S-00       59			
L12-09-13-P-S-S-00       0       6       865652       828091         L12-09-14-P-R-S-00       6       59       865652       828091         L12-09-15-P-E-S-00       59       65       865652       828091         L12-09-16-P-S-S-00       0       6       885652       828091         L12-09-16-P-S-S-00       0       6       885652       828143         L12-09-17-P-R-S-00       6       59       865652       828143         L12-09-17-P-R-S-00       6       59       865652       828174         L12-09-20-P-R-S-00       0       6       865652       828177         L12-09-21-P-E-S-00       0       6       865607       828117         L12-09-22-P-S-S-00       0       6       865607       828169         L12-09-22-P-S-S-00       0       6       865607       828169         L12-09-24-P-E-S-00       59       65       865607       828169         L12-09-24-P-E-S-00       59			
112-09-15-P-E-S-00       59       65       885652       828091         112-09-16-P-S-S-00       0       6       885652       828143         112-09-17-P-R-S-00       6       59       865652       828143         112-09-18-P-E-S-00       59       65       865652       828143         112-09-18-P-E-S-00       59       65       865652       828143         112-09-19-P-S-S-00       0       6       865652       828143         112-09-20-P-R-S-00       0       6       865607       828117         112-09-21-P-E-S-00       0       6       865607       828117         112-09-22-P-S-S-00       0       6       865607       828117         112-09-22-P-S-S-00       0       6       865607       828169         112-09-22-P-S-S-00       0       6       865607       828169         112-09-22-P-S-S-00       0       6       59       865607       828169         112-09-22-P-S-S-00       0       6       59       865607       828169         112-09-24-P-E-S-00       59       65       865607       828169       0       12.5       25       50       75       100			
112-09-15-P-E-S-00       59       65       885652       828091         112-09-16-P-S-S-00       0       6       885652       828143         112-09-17-P-R-S-00       6       59       865652       828143         112-09-17-P-R-S-00       6       59       865652       828143         112-09-17-P-R-S-00       6       59       865652       828143         112-09-18-P-E-S-00       0       6       865607       828117         112-09-21-P-E-S-00       0       6       865607       828117         112-09-22-P-S-S-00       0       6       865607       828169         112-09-22-P-S-S-00       0       6       59       865607       828169         112-09-22-P-S-S-00       0       6       59       865607       828169         112-09-24-P-E-S-00       59       65       865607       828169         112-09-24-P-E-S-00       59       65       865607       828169         112-0	L12-09-14-P-R-S-0	6 59 865652 828091	L12-09-19-P-S-S-00 L12-09-22-P-S-S-00
L12-09-16-P-S-S-00       0       6       865652       828143         L12-09-17-P-R-S-00       6       59       865652       828143         L12-09-18-P-E-S-00       59       65       865652       828143         L12-09-19-P-S-S00       0       6       865607       828117         L12-09-21-P-E-S-00       0       6       865607       828117         L12-09-21-P-S-S00       0       6       865607       828117         L12-09-22-P-S-S00       0       6       865607       828169         L12-09-24-P-E-S-00       59       65       865607       828169         L12-09-24-P-E-S-00       59			
L12-09-17-P-R-5-00       6       59       865652       828143         L12-09-18-P-E-S-00       59       65       865652       828143         L12-09-19-P-S-S-00       0       6       865607       828117         L12-09-21-P-E-S-00       59       65       865607       828117         L12-09-21-P-E-S-00       59       65       865607       828117         L12-09-22-P-S-S-00       0       6       865607       828169         L12-09-23-P-R-S-00       6       59       865607       828169         L12-09-24-P-E-S-00       59       65       865607       828169         L12-09-24-P-E-S-00       59       65       865607       828169         L12-09-24-P-E-S-00       59       65       865607       828169			
L12-09-19-P-S-5-00       0       6       865607       828117         L12-09-20-P-R-5-00       6       59       865607       828117         L12-09-21-P-E-5-00       59       65       865607       828117         L12-09-22-P-S-S-00       0       6       865607       828109         L12-09-23-P-R-5-00       6       59       865607       828169         L12-09-24-P-E-S-00       59       65       865607       828169         L12-09-24-P-E-S-00       59       65       865607       828169			
L12-09-20-P-R-S-00       6       59       865607       828117         L12-09-21-P-E-S-00       59       65       865607       828117         L12-09-22-P-S-S-00       0       6       865607       828169         L12-09-23-P-R-S-00       6       59       865607       828169         L12-09-24-P-E-S-00       59       65       865607       828169         L12-09-24-P-E-S-00       59       65       865607       828169			
L12-09-21-P-E-S-00       59       65       865607       828117         L12-09-22-P-S-S-00       0       6       865607       828169         L12-09-23-P-R-S-00       6       59       865607       828169         L12-09-24-P-E-S-00       59       65       865607       828169         L12-09-24-P-E-S-00       59       65       865607       828169			N
L12-09-22-P-S-5-00       0       6       865607       828169         L12-09-23-P-R-5-00       6       59       865607       828169         L12-09-24-P-E-S-00       59       65       865607       828169             0       12.5       25       50       75       100			
L12-09-23-P-R-5-00       6       59       865607       828169         L12-09-24-P-E-S-00       59       65       865607       828169             0       12.5       25       50       75       100			1 AL
112-09-24-P-E-S-00 59 65 865607 828169 0 12.5 25 50 75 100			
			0 12.5 25 50 75 100
	L12-09-07-P-S-Q-0	0 6 865697 828065	Feet

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Figure 48-2 below presents a tabular listing of all FSS samples collected within LSA 12-09 with associated IDs, sample types, collection intervals, coordinates, and notes.

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	F	SS SAMPI	LE & MEASUF	APPENDIX I REMENT LOO		COORDINATES	
Survey Area:	LSA	. 12	×	Description:		Burial Pits	Open Land Area
Survey Unit:	0	9		Description:		South Eastern S	urvey Unit in "Area 9"
Survey Type:	FS	S	-	Classificatio			Class 1
Survey Typer			-	Chussintuno			
Measurement or Sample ID	Surface or CSM	Туре	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes
L12-09-01-P-S-S-00	Uniform	S	430.2	429.7	865742	828039	Surface 6-inch grab
L12-09-02-P-R-S-00	Uniform	S	429.7	425.2	865742	828039	Root 59-inch composite
L12-09-04-P-S-S-00	Uniform	S	430.7	430.2	865742	828091	Surface 6-inch grab
L12-09-05-P-R-S-00	Uniform	S	430.2	425.7	865742	828091	Root 59-inch composite
L12-09-07-P-S-S-00	Uniform	S	429.9	429.4	865697	828065	Surface 6-inch grab
L12-09-08-P-R-S-00	Uniform	S	429.4	425.0	865697	828065	Root 59-inch composite
L12-09-10-P-S-S-00	Uniform	S	429.8	429.3	865697	828117	Surface 6-inch grab
L12-09-11-P-R-S-00	Uniform	S	429.3	424.8	865697	828117	Root 59-inch composite
L12-09-13-P-S-S-00	Uniform	S	429.8	429.3	865652	828091	Surface 6-inch grab
L12-09-14-P-R-S-00	Uniform	S	429.3	424.8	865652	828091	Root 59-inch composite
L12-09-16-P-S-S-00	Uniform	S	429.6	429.1	865652	828143	Surface 6-inch grab
L12-09-17-P-R-S-00	Uniform	S	429.1	424.7	865652	828143	Root 59-inch composite
L12-09-19-P-S-S-00	Uniform	S	429.6	429.1	865607	828117	Surface 6-inch grab
L12-09-20-P-R-S-00	Uniform	S	429.1	424.7	865607	828117	Root 59-inch composite
L12-09-22-P-S-S-00	Uniform	S	429.5	429.0	865607	828169	Surface 6-inch grab
L12-09-23-P-R-S-00	Uniform	S	429.0	424.6	865607	828169	Root 59-inch composite
L12-09-07-P-S-Q-00	Uniform	Q	429.9	429.4	865697	828065	Surface 6-inch grab
L12-09-14-P-R-Q-00	Uniform	Q	429.3	424.8	865652	828091	Root 59-inch composite
L12-09-25-P-S-B-00	Uniform	В	429.5	429.0	865654.4	828153.7	Biased 6-inch grab
L12-09-26-P-S-B-00	Uniform	В	429.6	429.1	865618.1	828120.0	Biased 6-inch grab

# Figure 48-2 FSS Sample Locations and Coordinates for LSA 12-09

Green shaded samples are the samples at each sample location, for use in WRS Test.

\*Elevations are in feet above mean sea level.

\*\* Missouri - East State Plane Coordinates [North American Datum (NAD) 1983]

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R

CSM: Three-Layer (Surface-Root-Excavation) or Uniform DCGLs used

Type: Systematic = S, Biased = B; QC =Q; Investigation = I

Quality Record

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# 48.3 Biased Soil Sampling

As discussed in FSSFR Volume 3, Chapter 1, Section 6.1.3, there are three key methods for identifying areas for biased soil sampling, the IAL, the Z-score of the FSS GWS, and the professional judgment of the HP Staff. For LSA 12-09 two (2) biased sample locations were selected within the SU based on the evaluation of the GWS survey data and HP Technician professional judgment. These biased locations represented the two maximum GWS measurements encountered within the SU. Biased samples are collected at the prescribed location to a depth of 6 inches below the exposed ground surface.

# 48.4 Judgmental/Sidewall Sampling for Tc-99

As an un-excavated SU, no Tc-99 sidewall sampling was necessary for LSA 12-09.

# 48.5 Quality Control Soil Sampling

Two QC field duplicate sample point were randomly selected and collected at systematic locations L12-09-07 and L12-09-14 for LSA 12-09.

# 49.0 FINAL STATUS SURVEY RESULTS LSA 12-09

# 49.1 Gamma Walkover Survey

Post-processed GPS coordinate data is accurate to within  $\pm 0.1$  m for the handheld GPS models used during the GWS. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same GPS location during the walkover, the most elevated radiological measurements are plotted "on top" (e.g. if any sidewalls featured more elevated readings than the floor directly below, the sidewall radiological measurements would overlie the lower floor readings).

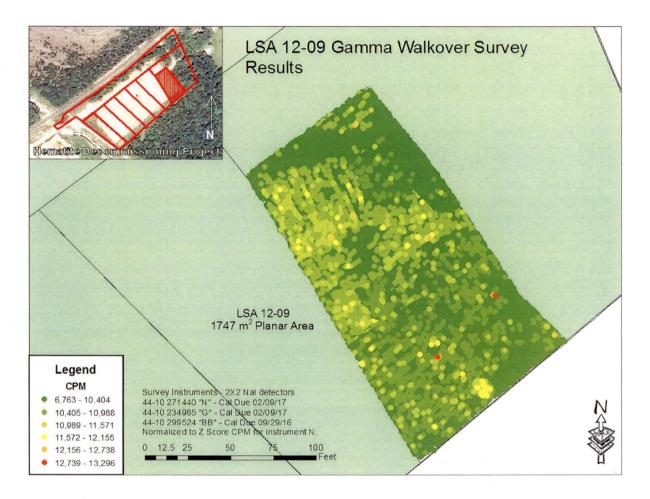
GWS measurements were collected in LSA 12-09 between May 6, 2016, and May 15, 2016.

# 49.1.1 GWS Results for LSA 12-09

For LSA 12-09, GWS count rates ranged between 6,763 gcpm and 13,296 gcpm, with a mean count rate of 9,821 gcpm. The median count rate was 10,030 gcpm and the standard deviation was 583 cpm. Figure 49-1 below presents a map of the complete GWS data set.

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Figure 49-1 Colorimetric GWS Plot for LSA 12-09

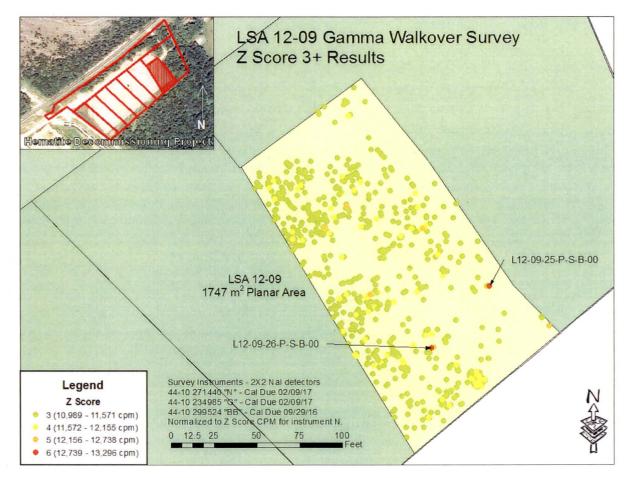


An evaluation of the entire GWS data set was performed to evaluate those small areas of elevated activity which exceeded three (3) standard deviations above the GWS mean measurement, (i.e., "+3 Z-score"). Two locations, L12-09-25 and L12-09-26, were selected for biased sample collection. These biased locations represented the maximum GWS measurements encountered within the SU.

Figure 49-2 below presents a map of the +3 Z-score GWS measurements within LSA 12-09, including the selected biased sampling locations (ID: L12-09-25-P-S-B-00 and L12-09-26-P-S-B-00).

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# Figure 49-2 Colorimetric GWS Plot for LSA 12-09 (Measurements > Z-score of 3)



All GWS data collected in LSA 12-09 was datalogged and post-processed in Graphical Information Software (GIS).

## 49.1.2 GWS Coverage Results LSA 12-09

FSSFR Volume 3, Chapter 1, Section 6.1.4, *Exposed Surfaces versus Accessible Surfaces*, provides a discussion and the criteria for evaluating the GWS coverage of a SU during FSS. Although 100% of accessible areas underwent GWS, the post survey processing of the GPS data indicated that the GWS covered 99.8% of the SU (see Table 49-1). As the evaluation indicates that the GPS coverage exceeded 95% with no readings approaching or exceeding the IAL of 4,000 net cpm in the vicinity of any apparent GPS coverage gaps, the GWS coverage for the SU has been evaluated to meet the intent of the "100% GWS coverage" requirement.

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# Table 49-1 GWS Gap Analysis LSA 12-09

	Total SU	GWS Gap	Gap	GWS	MARSSIM
	Pixels	Pixels	Percentage	Coverage	Class
LSA 12-09	155,315	308	0.2	99.8	1

## 49.2 Soil Sample Results LSA 12-09

Appendix G presents the analytical results and associated statistics for all FSS samples collected within LSA 12-09.

## 49.2.1 Surface Soil Sample Results LSA 12-09

There were eight systematic samples collected within the surface stratum (0 - 15 cm) of LSA 12-09. Additionally there were two biased samples and one QC sample collected from the topmost layer of soil. The maximum Uniform SOF result for the surface samples was 0.22.

## 49.2.2 Subsurface Soil Sample Results LSA 12-09

There were eight systematic locations within LSA 12-09 where root stratum composite sampling was necessary. The root stratum zone is between 0.15 and 1.50 m below final grade surface. At each of the eight root stratum composite sampling locations, the top six inches (1.50 - 1.65 m below final grade surface) of the underlying excavation stratum was also collected and archived, however these excavation samples were not required to be analyzed as no overlying root stratum sample exceeded a 0.5 SOF. The maximum SOF result of the subsurface samples collected in LSA 12-09 was 0.19.

## 49.2.3 WRS Evaluation

Per Step 7.8.3 of HDP-PR-FSS-721 *Final Status Survey Data Evaluation*, the Wilcoxon Rank Sum (WRS) statistical test was not required for LSA 12-09 since the difference between the maximum SU data set gross SOF and the minimum background area SOF was less than one using the Uniform Stratum criteria. However, for illustrative purposes, the WRS evaluation was still performed for LSA 12-09. All systematically collected samples regardless of depth are used to perform the WRS Test, however biased and QC sample results are not utilized in the WRS Test. The 16 systematically collected samples in LSA 12-09 were ranked against the adjusted activity concentrations of the 32 samples collected within the Background Reference Area. The SU passed the WRS Test since the ranked sum of the reference area ranks, or test statistic  $W_R$ , (1040) was greater than the critical value (860) for the test. As such, the null hypothesis that the SU average concentration is greater than the DCGL<sub>W</sub> was rejected. The WRS evaluation is also included in Appendix G.

# 49.2.4 Graphical Data Review LSA 12-09

Table 49-2 below presents summary results for the all systematically collected samples (includes surface, and root, but not biased or QC samples) collected within LSA 12-09, and the associated

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SOF when compared to the Uniform Stratum  $DCGL_ws$ . The arithmetic average concentration resulted in a SOF of 0.10.

Statistic	Ra-226 DCGL = 1.9 BKG = 1.07 (pCi/g)	Tc-99 DCGL = 25.1 (pCi/g)	Th-232 DCGL = 2.0 BKG = 1.0 (pCi/g)	U-234 DCGL=195.4 (pCi/g)	U-235 DCGL=51.6 (pCi/g)	U-238 DCGL=168.8 (pCi/g)	Sample SOF (Uniform DCGL)
Average	0.033	0.433	0.072	3.150	0.122	1.235	0.10
Minimum	0.00 ( <bkg)< td=""><td>0.00 (NEG)</td><td>0.00 (<bkg)< td=""><td>0.725</td><td>-0.142</td><td>0.839</td><td>0.02</td></bkg)<></td></bkg)<>	0.00 (NEG)	0.00 ( <bkg)< td=""><td>0.725</td><td>-0.142</td><td>0.839</td><td>0.02</td></bkg)<>	0.725	-0.142	0.839	0.02
Maximum	0.190	3.000	0.250	9.559	0.528	1.840	0.24

Table 49-2
LSA 12-09 FSS Sample Data Summary and Calculated SOF Values (Systematic)

Notes:

1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.

2. Average SOF for data set calculated using average radionuclide concentrations.

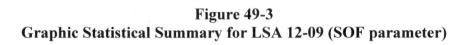
3. U-234 values are inferred from the U-235/U-238 ratio.

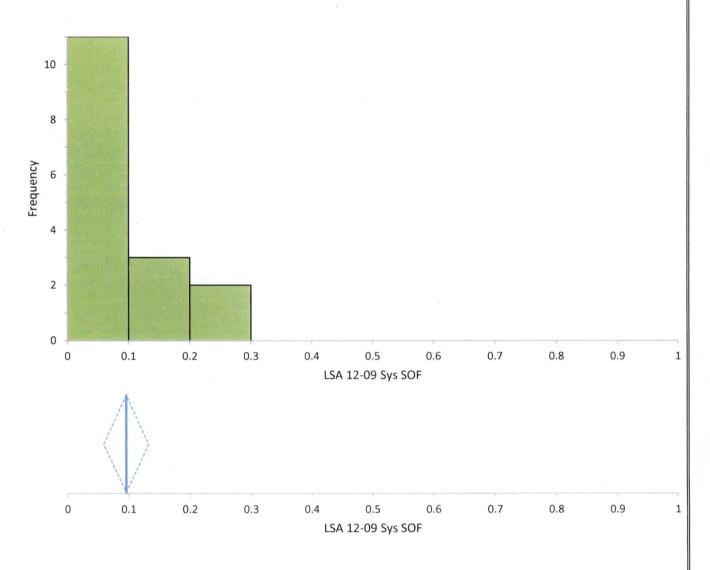
Section 8.2.2.2 of MARSSIM recommends a graphical review of FSS analytical data, to include at a minimum, a posting plot and a histogram. A frequency plot, or histogram, is a useful tool for examining the general shape of a data distribution. This plot is a bar chart of the number of data points within a certain range of values. The frequency plot will reveal any obvious departures from symmetry, such as skewness or bimodality (two peaks), in the data distribution for the survey unit. The presence of two peaks in the survey unit frequency plot may indicate the existence of isolated areas of residual radioactivity.

Figure 49-3 presents the overall statistical metrics for the SOF parameter for the 16 systematically collected samples from LSA 12-09. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 12-09. The middle graph presents the mean SOF (0.10 as indicated by the blue vertical line) of the sample population and the 95% confidence interval of the mean SOF represented by the blue diamond which is 0.06 to 0.13. The 97.87% confidence interval based on the median (0.06) of the sample results is 0.05 to 0.16. The bottom two charts present the various statistical metrics of the LSA 12-09 SOF data set, including the mean, median, standard deviation, minimum, maximum, confidence intervals, etc.

Figure 49-3 exhibits no unusual symmetry or bimodality concerns for the LSA 12-09 data associated with the systematically collected measurement locations.

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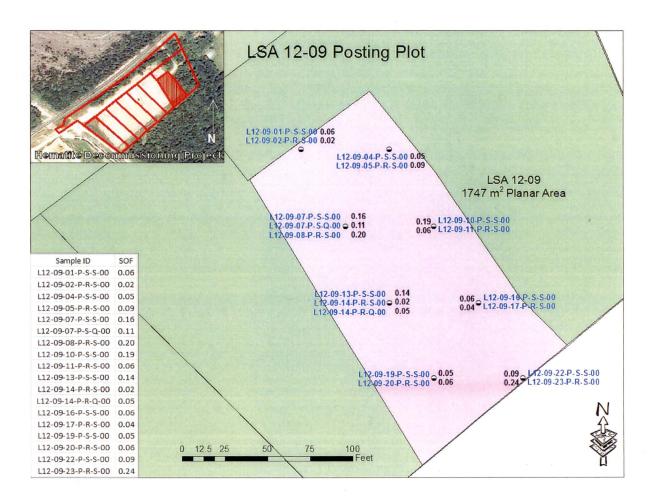
N 16

	Mean	95%	6 CI	Mean SE	SD	Variance	Skewness	Kurtosis
LSA 12-09 Sys SOF	0.10	0.06	0.06 to 0.13		0.07	0.00	0.9	-0.51
	Minimum	1st quartile	Median	97.87	% CI	3rd quartile	Maximum	IQR
LSA 12-09 Sys SOF	0.02	0.05	0.06	0.05	to 0.16	0.15	0.2	0.10

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A posting plot is simply a map of the survey unit with the data values (in this case the SOF values for each systematically collected sample) entered at the measurement locations. This potentially reveals heterogeneities in the data – especially possible patches of elevated residual radioactivity. The posting plot for LSA 12-09 is presented below in Figure 49-4. Figure 49-4 shows no unusual patterns in the data.

# Figure 49-4 Posting Plot for LSA 12-09 Systematic Measurement Locations



Appendix G to this report presents the complete analytical data set (in Microsoft Excel format) used to derive the summary statistics presented in Table 49-2, Figure 49-3, and Figure 49-4 above. A summary of the analytical data is presented in Table 49-3 below. Appendix U to this report presents the TestAmerica Analytical Laboratory soil sample reports.

Hematite Decommissioning Project

Sample Depth (ft)

0.00

0.50

0.00

0.50

0.00

0.50

0.00

0.50

0.00

0.50

0.00

0.50

0.00

0.50

0.00

0.50

0.00

0.50

0.00

0.00

Sample ID

L12-09-01-P-S-S-00

L12-09-02-P-R-S-00

L12-09-04-P-S-S-00

L12-09-05-P-R-S-00

L12-09-07-P-S-S-00

L12-09-08-P-R-S-00

L12-09-10-P-S-S-00

L12-09-11-P-R-S-00

L12-09-13-P-S-S-00

L12-09-14-P-R-S-00

L12-09-16-P-S-S-00

L12-09-17-P-R-S-00

L12-09-19-P-S-S-00

L12-09-20-P-R-S-00

L12-09-22-P-S-S-00

L12-09-23-P-R-S-00

L12-09-07-P-S-Q-00

L12-09-14-P-R-Q-00

L12-09-25-P-S-B-00

L12-09-26-P-S-B-00

Systematic Minimum Systematic Maximum Systematic Mean Systematic Median Systematic Standard Deviation FSSFR Volume 3, Chapter 9: Survey Area Release Record for Land Survey Area 12, Survey Units 03, 04, 05, 06, 07, 08, and 09 (LSA 12-03 through 12-09)

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											F	inal	Status	Surve	Table ey Ana			a: LSA	12-09	)												
	QC)												Te	estAmeri	ca Anal	tical R	tesults S	tep 8.3.2														
	as,			Ra	-226					Tc-99			3		Th-	232			Inferred U-234				U-235				U-238				Enr.	SOF
	Iype (Systematic, Bi	Result	Uncertainty	MDC	Qualifier	Net Result*	Corrected Result	Result	Corrected Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Net Result**	Corrected Result	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Enrichment (%)	SOF
	S	1.100	0.167	0.077	N/A	0.030	0.030	-0.007	0.000	0.120	0.221	U	1.080	0.173	0.103	N/A	0.080	0.080	0.839	NA	NA	NA	-0.076	0.234	0.529	U	0.839	0.313	0.871	U	0.7	0.06
	S	1.060	0.166	0.085		-0.010		-0.029	0.000	0.025	0.239	U	0.956	0.202	0.113	N/A	-0.044	0.000	1.933	NA	NA	NA	0.102	0.231	0.384	U	1.050	0.538	0.824	N/A	1.5	0.02
-	-	0.985	0.149	0.076	-	-0.085	0.000	0.565	0.565	0.102	0.224	N/A	0.889	0.150	0.111	N/A	-0.111	0.000	3.328	NA	NA	NA	0.181	0.120	0.161	N/A	1.220	0.317	0.798	N/A	2.3	0.05
-	S	1.000	0.158	0.079	N/A	-0.070		-0.007	0.000	0.066	0.234	U N/A	1.130 0.899	0.188	0.130	N/A	0.130	0.130	2.153	NA	NA	NA	0.111	0.244	0.561 0.179	U N/A	1.530 1.480	0.741	0.926	N/A N/A	1.2 2.9	0.09
-	S	0.957	0.141	0.064		-0.113	0.000	3.000 0.131	3.000 0.131	0.343	0.241	U U	1.210	0.140	0.111	N/A N/A	0.210	0.000	5.046	NA NA	NA	NA NA	-0.018	0.127	0.600	U U	1.400	0.520	0.757	N/A	0.7	0.16
	S S	1.180	0.176	0.004		0.110	0.110	0.356	0.356	0.094	0.220	N/A	1.100	0.186	0.155	N/A	0.100	0.100	9.559	NA	NA	NA	0.528	0.204	0.239	N/A	1.840	0.616	0.886	N/A	4.3	0.20
	S	1.110	0.156	0.065	-	0.040	0.040	-0.021	0.000	0.050	0.231	U	1.070	0.163	0.112	N/A	0.070	0.070	0.909	NA	NA	NA	-0.102	0.316	0.525	U	0.909	0.293	0.782	N/A	0.7	0.06
	S	0.991	0.141	0.056	-	-0.079		1.830	1.830	0.174	0.236	N/A	1.030	0.183	0.094	N/A	0.030	0.030	8.032	NA	NA	NA	0.443	0.160	0.202	N/A	1.240	0.540	0.820	N/A	5.3	0.14
	S	0.923	0.152	0.078		-0.147	0.000	-0.085	0.000	0.059	0.223	U	1.010	0.176	0.068	N/A	0.010	0.010	1.270	NA	NA	NA	-0.058	0.133	0.579	U	1.270	0.755	0.937	N/A	0.7	0.02
		0.825	0.132	0.063	N/A	-0.245	0.000	0.429	0.429	0.155	0.232	N/A	1.010	0.180	0.096	N/A	0.010	0.010	4.367	NA	NA	NA	0.240	0.161	0.215	N/A	1.240	0.323	0.807	N/A	3.0	0.06
	S	0.934	0.128	0.062	N/A	-0.136	0.000	0.228	0.228	0.152	0.245	U	1.050	0.159	0.060	N/A	0.050	0.050	0.725	NA	NA	NA	0.033	0.051	0.528	U	0.861	0.280	0.724	N/A	0.6	0.04
	S	0.953	0.143	0.062	N/A	-0.117	0.000	0.077	0.077	0.068	0.234	U	0.949	0.171	0.083	N/A	-0.051	0.000	6.393	NA	NA	NA	0.353	0.162	0.188	N/A	1.370	0.517	0.751	N/A	3.9	0.05
	S	1.020	0.161	0.082	N/A	-0.050	0.000	0.094	0.094	0.071	0.230	U	1.080	0.173	0.109	N/A	0.080	0.080	1.080	NA	NA	NA	-0.023	0.035	0.629	U	1.080	0.564	0.867	N/A	0.7	0.06
	S	0.992	0.136	0.068	N/A	-0.078	0.000	0.210	0.210	0.077	0.218	U	1.130	0.186	0.092	N/A	0.130	0.130	2.053	NA	NA	NA	0.109	0.159	0.475	U	1.110	0.303	0.738	N/A	1.6	0.09
	S	1.260	0.194	0.080	N/A	0.190	0.190	-0.034	0.000	0.085	0.241	U	1.250	0.216	0.145	N/A	0.250	0.250	1.310	NA	NA	NA	-0.142	0.291	0.713	U	1.310	0.671	1.030	N/A	0.7	0.24
	Q	0.842	0.138	0.075	N/A	-0.228	0.000	1.220	1.220	0.120	0.216	N/A	0.786	0.141	0.127	N/A	-0.214	0.000	8.171	NA	NA	NA	0.451	0.158	0.214	N/A	1.350	0.334	0.823	N/A	5.0	0.11
	Q	1.110	0.152	0.064	N/A	0.040	0.040	-0.074	0.000	0.069	0.231	U	1.040	0.157	0.113	N/A	0.040	0.040	1.360	NA	NA	NA	-0.120	0.120	0.509	U	1.360	0.532	0.797	N/A	0.7	0.05
	-	0.793	0.126	0.068		-0.277	0.000	0.413	0.413	0.070	0.190	N/A	1.040	0.173	0.077	N/A	0.040	0.040	5.329	NA	NA	NA	0.294	0.169	0.235	N/A	1.240	0.370	0.843	N/A	3.6	0.08
	в	0.979	0.144	0.067	N/A	-0.091	0.000	0.195	0.195	0.120	0.227	U	0.968	0.155	0.125	N/A	-0.032	0.000	4.218	NA	NA	NA	0.231	0.181	0.193	N/A	1.330	0.537	0.806	N/A	2.7	0.04
		0.000 0.000						0.0	00				0.72				-0.1				0.83			2.1	0.02							
1				0.1	190			<b> </b>		3.000					0.2					9.5				0.52			<u> </u>	1.84			e t (%)	0.24
					033					0.433					0.0					3.1				0.12				1.23			Average Enrichment	0.10
-					000			<b> </b>		0.113					0.0					1.99				0.10			<u> </u>	1.24			Av	0.06
ation	-		arouth .		061		1.07			0.821			Those	hlun -	0.0	77				2.76	65	1.11		0.20	01			0.26	54		<u> </u>	0.07
1		with ing	growth, u	ise Ra2	26 bkg		1.07		1				Th232	bkg =	1.0										Carlos and		269.00		-			

# Table 10-3

NOTES:

Gross results in units of pCi/g.

\* Background with ingrowth (1.07 pCi/g) subtracted from gross result.

\*\*Background (1.0 pCi/g) subtracted from gross result.

U Qualifier: Result is less than the sample detection limit.

All uncertainty values are reported at the 2-sigma confidence level.

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## 49.2.5 Biased Soil Sample Result LSA 12-09

Two (2) biased samples were collected from LSA 12-04. The sample collected at location L12-09-25 represented the maximum GWS measurement (13,296 gcpm) within the SU, and had a result of 0.08 Uniform SOF.

## 49.2.6 Quality Control Soil Sample Result LSA 12-09

Two QC field duplicate sample points were randomly selected for LSA 12-09 which were collected at systematic locations L12-09-07 and L12-09-14.

For the 18 samples (i.e., 16 systematic + 2 biased) collected within LSA 12-09, two field duplicate samples were collected. This frequency equates to 11.1%, (i.e. 2/18). Form HDP-PR-FSS-703-1 documents that the duplicate sample result comparison with the partner's sample results that all comparison criteria were less than the calculated warning limits (see Figure 49-5 below).

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	Form H	DP-PR-FS	S-703-1 F	ield D	Figure 49 Puplicate Sa		ssessment I	LSA 12-(	)9 (1 of 2	2)		<u> </u>
Hematite	Procedure: HDP-PR-	-FSS-703, Fin	al Status Sur	vey Qua	lity Control				· ····································		· · · ·	
Decommissioning Project								Revisi	on: 2		Page 1	of 1
			FIE			AMPLE A	SSESSMENT					
Survey Unit No.:	LSA 12-09				Survey Unit D				a in "Area	13"	· · · · · · · · · · · · · · · · · · ·	
	1			<u> </u>	Field Duplica	-	Average	Nuclide			_	Statistic
Sample ID	Field Duplicate Sample ID Radionucli		Sample (p Activity (x <sub>i</sub> )		(pCi/ Activity (x <sub>i</sub> )	g) MDC	Activity $(\overline{X})$ (pCi/g)	DCGL (pCi/g)	Statistic <sup>2</sup>	Warning Limit	Control Limit	Exceeds Limit? (Y/N)
L12-09-07-P-S-S-00	L12-09-07-P-S-Q-00	Ra-226	0.957	0.0642	0.842	0.0746	0.900	1.9	0.115	0.269	0.403	N
L12-09-07-P-S-S-00	L12-09-07-P-S-Q-00	Tc-99	3	0.241	1.22	0.216	2.110	25.1	1.78	3.552	5.321	N
L12-09-07-P-S-S-00	L12-09-07-P-S-Q-00	Th-232	0.899	0.111	0.786	0.127	0.843	2.0	0.113	0.283	0.424	N
L12-09-07-P-S-S-00	L12-09-07-P-S-Q-00	U-234 <sup>1</sup>	5.046	N/A	8.171	N/A	6.608	195.4	3.125	27.649	41.425	N
L12-09-07-P-S-S-00	L12-09-07-P-S-Q-00	U-235	0.277	0.179	0.451	0.214	0.364	51.6	0.174	7.301	10.939	N
L12-09-07-P-S-S-00	L12-09-07-P-S-Q-00	U-238	1.48	0.757	1.35	0.823	1.415	168.8	0.130	23.885	35.786	Ň
	o MDC available. nt is not necessary if the Thomes / c						Reviewed by:	WC	art En	res/	W.C.	hA
Date:	11=23-						Date: //	23/1	6	/		

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	Form HD	P-PR-FSS	5-703-1 F		Figure 49 uplicate Sa		ssessment l	LSA 12-	09 (2 of	2)		
Hematite	Procedure: HDP-PR-	FSS-703, Fin	al Status Sur	vey Qua	lity Control	<u>.</u>						
Decommissioning Project								Revisi	ion: 2		Page 1	of I
			FIE		ORM HDP-I PLICATE SA		03-1 .SSESSMENT					
Survey Unit No.:	LSA 12-09				Survey Unit D	escription:	Class I Laydow	n Land Are	a in "Area	13"		
Sample ID	Field Duplicate Sample ID	Radionuclide	Sample (p	-	Field Duplica (pCi/ Activity (x <sub>i</sub> )	te Sample	Average Activity $(\bar{x})$ (pCi/g)	Nuclide DCGL (pCi/g)	Statistic <sup>2</sup>		Control Limit	Statistic Exceeds Limit? (Y/N)
L12-09-14-P-R-S-00	L12-09-14-P-R-Q-00	Ra-226	0.923	0.0783	1.11	0.0639	1.017	1.9	0.187	0.269	0.403	N
	L12-09-14-P-R-Q-00	Tc-99	-0.0848	0.223	-0.0738	0.231	-0.079	25.1	NA	3.552	5.321	NA
L12-09-14-P-R-S-00	L12-09-14-P-R-Q-00	Th-232	1.01	0.0676	1.04	0.113	1.025	2.0	0.030	0.283	0.424	N
L12-09-14-P-R-S-00	L12-09-14-P-R-Q-00	U-234 <sup>1</sup>	1.270	N/A	1.360	N/A	1.315	195.4	0.090	27.649	41.425	N
L12-09-14-P-R-S-00	L12-09-14-P-R-Q-00	U-235	-0.0584	0.579	-0.12	0.509	-0.089	51.6	NA	7.301	10.939	NA
L12-09-14-P-R-S-00	L12-09-14-P-R-Q-00	U-238	1.27	0.937	1.36	0.797	1.315	168.8	0.090	23.885	35.786	N
Comments: 1. U-234 is inferred. n 2. Duplicate assessme	o MDC available. nt is not necessary if the	result of either	sample is < I	MDC.								
Performed by: 1/	jomes fard	1/4	- Be	Ĭ.			Reviewed by:	w.U	aih Er	oj/h	). Cl	En
Date:	11-23-16		· .				Date: ///	23/14	1	•		
Quality Record					-				•			

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# 49.3 Tc-99 Hot Spot Assessment LSA 12-09

There is no historical sampling data available for this area since it was always considered a nonimpacted area prior to the storage of potential reuse soils within the LSA. As a previously unimpacted area there is no history of a Tc-99 sample result ever exceeding the Tc-99 Uniform DCGL<sub>w</sub>, as only potential reuse soil was placed within the LSA. The highest Tc-99 sample result collected from both Final RASS and FSS was 3.0 pCi/g. Therefore there is no concern for a potential Tc-99 hot spot exceeding the DCGL<sub>w</sub> of 25.1, and there is no reason to perform a Tc-99 hot spot assessment.

# 50.0 ALARA EVALUATION LSA 12-09

All samples collected within LSA 12-09 were evaluated against the Uniform Stratum DCGL<sub>w</sub>. For LSA 12-09 no sample result exceeded a SOF of 1.0. The average SOF result, based on all systematically collected samples, was 0.10 for LSA 12-09. The average SOF equates to residual activity contributions from the survey unit area of 2.5 mrem/yr for LSA 12-09. Groundwater Monitoring Well data provided in FSSFR Volume 6, Chapters 2 and 3 {ML16287A528} and Chapter 4 {ML16342B552}, indicate that the groundwater dose contribution will be a fraction of the MCLs. Nevertheless, a maximum groundwater contribution assumption of 4.0 mrem/yr based upon the EPA MCLs will be added to the total estimated dose for LSA 12-09. Adding these dose contributions together, the total estimated dose for LSA 12-09 is 6.5 mrem/yr.

Since the estimated Total Effective Dose Equivalent is well below the regulatory release criterion of 25 mrem/yr, the conclusion of the ALARA evaluation is that the FSS of LSA 12-09 was successful and that there would be no discernable benefit to the health and safety of the public in attempting to further reduce the results of FSS by performing remediation of LSA 12-09.

# 51.0 FSS PLAN DEVIATIONS LSA 12-09

# 51.1 Remedial Actions during FSS

There was no remedial action in LSA 12-09.

# 51.2 Adjustments to Scan MDC Calculations

Scan MDCs for LSA 12-09 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD- FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. The assumed LSA background count rate of 10,000 cpm was applied to determine the prospective Scan MDCs, and the actual mean count rate from the FSS survey was 9,821 cpm. Therefore the calculated Scan MDCs are appropriate, and no adjustments need to be made.

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# 52.0 DATA QUALITY ASSESSMENT

The DQO process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process are presented in Volume 3, Chapter 1, Section 4.0 of the FSSFR and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

# 52.1 Data Quality Assessment for LSA 12-09

The Data Quality Assessment of the survey methodology, sampling and sample analysis results, and the Quality Control sampling and analysis results to ascertain the validity of the conclusion for LSA 12-09 (see Figure 52-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-416 (*Operation of the Ludlum 2221 for Final Status Survey*).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.
- The systematic samples that were collected (on a random-start triangular grid) and the gamma scan surveys that were conducted were performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.
- All samples sent for analysis at the approved offsite laboratory (TestAmerica) were tracked on a chain of custody form in accordance with HDP-PR-QA-006, *Chain of Custody*.
- Quality Control sample results were verified to meet the acceptance criteria as specified in HDP-PR-FSS-703, *Final Status Survey Quality Control*.
- LSA 12-09 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.
- The WRS Test is not necessary when the difference between the maximum survey unit data set measurement SOF and the minimum background area measurement SOF is less than or equal to one. For LSA 12-09, no individual gross SOF result in the FSS data set exceeded the SOF of the minimum background reference area measurement by more than one using the Uniform Stratum criteria. Therefore, the WRS Test was not required for LSA 12-09. However the WRS Test was still performed for illustrative purposes. Since the test statistic, WR (1040) exceeded the critical value (860), the FSS data set passed the WRS Test and the null hypothesis was rejected. The WRS Test worksheet is presented in Appendix G.
- Two biased soil samples were collected from the locations of the highest gamma count rate within the SU, with a maximum result of 0.08 Uniform SOF.

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I I I I	The maximum SOF result for all surface samples within LSA. The maximum SOF result for all subsurface samples within LSA. The average SOF result for all systematically collected samples was 0.10, with an upper 95% confidence level (UCL <sub>mean</sub> 0.95) of	A 12-09 was 0.24. within LSA 12-09	
L n	No FSS sample result in LSA 12-09 exceeded a SOF of 1.0 as compared to the Jniform Stratum criteria, therefore an EMC or supplemental investigations was not required. For the same reason, no comparisons to the alternate "Three-Layer" nulti-CSM (i.e. Surface, Root and Excavation) DCGLs were necessary.		

- A retrospective sampling frequency evaluation was performed to determine if sufficient statistical power exists to reject the null hypothesis based on the total number (8) of systematic samples actually collected within LSA 12-09. The successful result of the retrospective power evaluation presented in Table 52-1 for LSA 12-09 indicates that the minimum number of samples required (8) for the WRS Test were equal to the number of sampling locations actually collected within LSA 12-09. The methodology used for the retrospective sampling frequency evaluation is similar to the prospective sample size determination performed during FSS Plan Development except that actual FSS sample results and statistics are used in the sample size verification. Specifically, the mean and standard deviation of the eight LSA surface samples (i.e., the WRS Test sample data set) are used to derive the relative shift for each LSA. Given the HDP Type I and Type II errors of 0.05 and 0.10, respectively, the calculated relative shift is then correlated to a minimum sample size number as provided in Table 5-1 of MARSSIM.
- HDP staff ensured that a visual inspection of the SU configuration and of the Isolation & Control measures were performed periodically, and confirmed that there were no instances of potential cross contamination from weather events until the FSS of all remaining areas at HDP were completed.

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Table 52-1Retrospective Sample Size Verification for LSA 12-09

Uniform DCGL Criteria Evaluation				
N/2 Value Verification				
Isotope(s)	SOF (Ra/Tc/Th/Iso U)			
St. Dev.	0.07			
DCGL <sub>SOF</sub>	1			
LBGR (Mean)	0.10			
Shift	0.90			
Relative Shift ( $\Delta/\sigma$ )	13.08			
MARSSIM Table 5.1 (Pr)	1.000000			
N	12			
N + 20%	14.4			
N/2	8			
FSS N/2	8			
Verification Check	SUFFICIENT MEASUREMENTS			

"N/2" Corresponds to the number of survey unit measurement locations required for the WRS Test

MARSSIM Table 5.1				
Δ/σ	Pr			
0.1	0.528182			
0.2	0.556223			
0.3	0.583985			
0.4	0.611335			
0.5	0.638143			
0.6	0.664290			
0.7	0.689665			
0.8	0.714167			
0.9	0.737710			
1.0	0.760217			
1.1	0.781627			
1.2	0.801892			
1.3	0.820978			
1.4	0.838864			
1.5	0.855541			
1.6	0.871014			
1.7	0.885299			
1.8	0.898420			
1.9	0.910413			
2.0	0.921319			
2.25	0.944167			
2.5	0.961428			
2.75	0.974067			
3.0	0.983039			
3.5	0.993329			
4.0	0.997658			
4.01	1.000000			

# MARSSIM Table 5.2, $\alpha = 0.05$ , $\beta = 0.10$

α ( <b>or</b> β)	$Z_{1-\alpha}$ (or $Z_{1-\beta}$ )
0.005	2.576
0.01	2.326
0.015	2.241
0.025	1.960
0.05	1.645
0.10	1.282
0.15	1.036
0.2	0.842
0.25	0.674
0.30	0.524

	matite missioning	1		, Chapter 9: Surv 04, 05, 06, 07, 08	•	•	•	Area 1
	roject	Re	evision: 1	· ·			Page 188 of	f 191
	D	ata 1	Evaluation Ch	Figure 52 ecklists prepare		09 (page 1 o	of 2)	
	Hematite		Procedure: HDP-PI	R-FSS-721, Final Statu	is Survey Data Eva	luation		
	Decommission Project	ing				Revision: 10	Appendix G-1, Page 1 of 2	
	FIN	IAL S	STATUS SURVEY	APPENDIX DATA QUALITY O		VIEW CHECH	LIST	
	Survey Ar Survey Ur		LSA 12 09		Laydown Area, P Class 1 Laydown		Area 13"	
	to dat	a ana		analysis results that vindividually reviewed this procedure?		Yes 🛛 No	D []	
		ed at	the locations speci	nents and/or sample fied in the FSSP and		Yes 🛛 N	o 🗌	
				performed of the ar SS Sample Instruction		Yes 🕅 N	o 🗌	
				and/or samples been t FSSP & the FSS Sam		Yes 🛛 N	0 🗌 NA 🗌	
				mples or measurement nated as a QC sample?		Yes 🔀 🛛 N	0 🗌 NA 🗍	
	capab	le of		measure or analyze or gross activity at a vel?		Yes 🛛 N	0	
	analyz	ze da		ruments that were use ne of use and were t ble source?		Yes 🔀 🛛 N	o 🗌 .	
	8. Were	the i	nstruments successf	ully response-checked e day the data was mea		Yes 🛛 N	0	-
	9. Do th	e sam	ples match those ide	entified on the chain o	f custody?	Yes 🔀 🛛 N	0 🗌 NA 🗌	
				et the acceptance crites Survey Quality Cont		Yes 🛛 N	0	
	11. Are a	l Lab	ooratory QC paramet	ers within acceptable	limits?	Yes 🛛 N	o 🗌	
				of the questions above resolve the discrepane		he discrepancy	as well as any	
,	Comments	: N/A	<b>A</b> .					

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Hematite	Procedure: HDF	-PR-FSS-721, Final S	tatus Survey Data E	valuation	
Decommissioning Project				Revision: 10	Appendix G-1, Page 2 of 2
FINAL	STATUS SURV	APPENDI EY DATA QUALITY		EVIEW CHEC	KLIST
Survey Area:	LSA 12	Descripti	on: Laydown Area	a, Plant Soils SE.	Α
Survey Unit:	. •	Descripti	on: Class i Laydo	wn Land Area in	"Area 13"
Discrepancy:	N/A				
<u></u>			· · · · · · · · · · · · · · · · · · ·		
•					· · · · · · · · · · · · · · · · · · ·
<u> </u>					
11. Have the a. If "No"	corrective actions	resolved the discrepar s form to the RSO.	ncy with the data?	· · · · · · · · · · · · · · · · · · ·	
<ul> <li>11. Have the o</li> <li>a. If "No"</li> <li>12. The follow</li> </ul>	corrective actions ', then forward this ving questions wi	resolved the discrepar s form to the RSO. Il be answered by the l	ncy with the data?	Yes 🗌 N	No 🗌 NA 🛛
<ul> <li>Have the oracle of the following of the followin</li></ul>	corrective actions ', then forward the ving questions wi nswer to question	resolved the discrepar s form to the RSO.	ncy with the data?	Yes 🗌 N	· · · · · · · · · · · · · · · · · · ·
<ul> <li>11. Have the oral a. If "No"</li> <li>12. The follow</li> <li>a. If the a still value</li> <li>b. If "No"</li> </ul>	corrective actions ', then forward the ving questions wi nswer to question lid? ', then are the exis	resolved the discrepar s form to the RSO. Il be answered by the l	ncy with the data? RSO. the affected data nts or samples	Yes 🗌 N Yes 🗌 N	No 🗌 NA 🛛
<ul> <li>Have the oral of the second second</li></ul>	corrective actions r, then forward the ving questions wi nswer to question lid? r, then are the exist ont to demonstrate r, then direct the a	resolved the discrepar s form to the RSO. Il be answered by the 11 was "No", then is sting valid measureme	ncy with the data? RSO. the affected data nts or samples invey unit?	Yes I N Yes I N Yes I N	
<ul> <li>Have the oral of the second second</li></ul>	corrective actions ', then forward thi ving questions wi nswer to question lid? ', then are the exist ent to demonstrate ', then direct the a strate compliance	resolved the discrepar s form to the RSO. Il be answered by the is 11 was "No", then is sting valid measureme compliance for the su cquisition of additiona	ncy with the data? RSO. the affected data nts or samples urvey unit? al measurements or s	Yes I N Yes I N Yes I N	
<ul> <li>11. Have the of a. If "No"</li> <li>12. The follow</li> <li>a. If the a still value</li> <li>b. If "No" sufficie</li> <li>c. If "No" demonstration</li> </ul>	corrective actions r, then forward the ving questions wi nswer to question lid? r, then are the exist ent to demonstrate r, then direct the a strate compliance	resolved the discrepar s form to the RSO. Il be answered by the is 11 was "No", then is sting valid measureme compliance for the su cquisition of additiona	ncy with the data? RSO. the affected data nts or samples urvey unit? al measurements or s	Yes I N Yes I N Yes I N Yes I N Samples as neces	No $\square$ NA $\boxtimes$ No $\square$ NA $\boxtimes$ No $\square$ NA $\boxtimes$ sary to
<ul> <li>11. Have the of a. If "No"</li> <li>12. The follow a. If the a still value b. If "No" sufficience c. If "No" demonstrational demonstration of the strategy of the str</li></ul>	corrective actions r, then forward the ving questions wi nswer to question lid? r, then are the exist ent to demonstrate r, then direct the a strate compliance	resolved the discrepar s form to the RSO. Il be answered by the is 11 was "No", then is sting valid measureme compliance for the su cquisition of additiona	ncy with the data? RSO. the affected data nts or samples urvey unit? al measurements or s	Yes I N Yes I N Yes I N Yes I N Samples as neces	No $\square$ NA $\boxtimes$ No $\square$ NA $\boxtimes$ No $\square$ NA $\boxtimes$ sary to

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# 53.0 CONCLUSION LSA 12-09

An adequate quantity and quality of radiological surveys and samples, as well as the corresponding laboratory analysis has been performed, evaluated and documented to demonstrate that the dose associated with all sources within SU LSA 12-09 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402.

	LSA 12-09 SOF and Dose Summation							
	AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	BURIED PIPING	REUSE SOIL	TOTAL		
SOF	0.10	N/A	0.16	N/A	N/A	0.26		
DOSE	2.5 mrem/year	N/A	4.0 mrem/year	N/A	N/A	6.5 mrem/year		

Table 53-1JSA 12-09 SOF and Dose Summation

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#### 54.0 **REFERENCES**

- 54.1 DO-08-004, Hematite Decommissioning Plan {ML092330123}.
- 54.2 DO-08-003, Radiological Characterization Report, July 2009 {ML092870496}
- 54.4 Westinghouse letter HEM-11-96, dated July 5, 2011, Final Supplemental Response to NRC Request for Additional Information on the Hematite Decommissioning Plan and Related Revision to a Pending License Amendment Request {ML111880290}
- 54.5 HDP-TBD-FSS-002, Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)

## 55.0 APPENDICES (To Be Provided On Separate Data Disc)

- APPENDIX A: Analytical Data Evaluation Spreadsheets for LSA 12-03
- APPENDIX B: Analytical Data Evaluation Spreadsheets for LSA 12-04
- APPENDIX C: Analytical Data Evaluation Spreadsheets for LSA 12-05
- APPENDIX D: Analytical Data Evaluation Spreadsheets for LSA 12-06
- APPENDIX E: Analytical Data Evaluation Spreadsheets for LSA 12-07
- APPENDIX F: Analytical Data Evaluation Spreadsheets for LSA 12-08
- APPENDIX G: Analytical Data Evaluation Spreadsheets for LSA 12-09
- APPENDIX H: FSS Plan Development for LSA 12-03
- APPENDIX I: FSS Plan Development for LSA 12-04
- APPENDIX J: FSS Plan Development for LSA 12-05
- APPENDIX K: FSS Plan Development for LSA 12-06
- APPENDIX L: FSS Plan Development for LSA 12-07
- APPENDIX M: FSS Plan Development for LSA 12-08
- APPENDIX N: FSS Plan Development for LSA 12-09

APPENDIX O: TestAmerica Laboratory Analytical Data Reports for LSA 12-03
APPENDIX P: TestAmerica Laboratory Analytical Data Reports for LSA 12-04
APPENDIX Q: TestAmerica Laboratory Analytical Data Reports for LSA 12-05
APPENDIX R: TestAmerica Laboratory Analytical Data Reports for LSA 12-06
APPENDIX S: TestAmerica Laboratory Analytical Data Reports for LSA 12-07
APPENDIX T: TestAmerica Laboratory Analytical Data Reports for LSA 12-08
APPENDIX U: TestAmerica Laboratory Analytical Data Reports for LSA 12-08